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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor — CHARLES WHITING BAKER, Consulting Editor

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Bay State Against Radicalism

Coolidge by 125,000. Thus does Massachusetts give the answer to radicalism.

The Critical Hour

Crises have a tendency to force us back to fundamentals. Attorney-General Palmer thus puts the issue in the coal strike: "The question which we must now try out is whether the by-laws of the miners' union shall prevail against the great needs of the people and whether the supreme authority of any non-governmental body can be substituted for the authority of the Government under the law." And again, "This is the critical hour in the life of our country. The test is being made whether the Government has the right and the power to protect all the people from a national disaster which would be inflicted upon them by a single group for its own advantage." The Attorney-General speaks the mind of the country.

No Tremendous Emigration

One of the difficulties in the labor problem seems to have been exaggerated. For some months there have been statements abroad about the tremendous emigration of that foreign element which has made up the bulk of the common labor of the country. Now the Commissioner General of Immigration states that only 102,513 foreigners have left the United States since the signing of the armistice, only about 20,000 more than the emigration during the 12 months which ended June 30, 1919. For the five years which ended at that time 618,223 emigrants departed, so that the present outflow is but little greater than normal during the war. While the war stopped immigration, can it not be expected that, with the cost of living as high on the Continent as it is here and with every prospect of higher taxes, the balance in favor of immigration will return before long?

Americanization's Leaders

Back five years or more a group of students of social and industrial conditions concluded that the un-Americanized foreigner was a potential danger to our institutions, and that he was doing himself an injustice by not getting in tune mentally with the spirit of America. They set about to arouse the public to the pressing importance of the subject, and by the hardest sort of uphill work finally made an impression on our industrial leaders and got the Government to help in the work. The war gave a tremendous impetus to their efforts. Most of us awoke then to the peril of the un-Americanized foreigner, but since the recent revelations regarding the activities of our imported Bolsheviki, the whole country has come to see the need for systematic methods of developing among our foreign-born population a genuine sympathy for and attachment to America and its institutions. In our new-found devotion to a necessary work we owe a tribute to those who foresaw its need and long since developed its methods. To Miss Frances A. Keller, in particular, leader always in Americanization propaganda, grateful recognition is due.

A New View on French Reconstruction

Further evidence against the probability of an extensive participation by American engineering, construction and manufacturing interests in French reconstruction is piling up day by day. Immediately following the armistice this country was deluged by a flood of loose statement and wild conjecture regarding our participation in the post-war work overseas. To one at all familiar with conditions and people abroad the situation, so far as this country was concerned, appeared anything but promising and during the early part of the present year this journal on several occasions pointed out the wisdom of discounting rather heavily the tales of opportunity for Americans across the Atlantic Yet the idea persisted that the American engineer, contractor and manufacturer were the agencies necessary to "save" France-- and incidentally to profit rather handsomely in the doing. What France was to be "saved" from was never quite clear. Nevertheless, a number of American organizations-- engineers, contractors and manufacturers-- sent emmissaries to France in quest of the Golden Fleece of reconstruction. Many of these Argonauts have since returned sadder but wiser men. From one of them still abroad, a man of wide experience as an engineer and a constructor, some very pertinent comment on general conditions has been received in a letter from France. In direct contrast to the belief in a big foreign market for American manufacturers in Europe this observer makes the radical statement that perhaps things may work out the other way-- that is, that American interests instead of exporting to France may take advantage of favorable conditions in the European labor market, establish foreign connections, produce abroad and <u>import</u> to America.

In support of this highly interesting point of view the low wages current in France and Belgium are cited. A quotation from the letter referred to above is apropos: "I saw men working for 6-1/2 francs per day

(at the present rate of exchange this is about 75¢ per day). They were breaking and loading pig iron on cars for 87-1/2¢ per ton. In Germany labor is drawing (figured at the present rate of exchange) 7 or 8 cents and mechanics about 13 cents. Coal is high now but conditions are going to improve very much faster than people realize. There is a lot more coal available all over Europe than you would gather from reading the newspaper. The whole situation convinces me, once this temporary buying is over, that America will not sell anything manufactured to Europe. I am convinced that Americans will contrive to gain connections whereby they will produce under these favorable conditions to import into America. If I am not wrong, nothing but the lack of ships will prevent the German from having the South American trade all back".

The role of prophet in these changing times is a hazardous one. For the present at least it seems reasonably clear, however, that the foreign opportunities for both American engineer and manufacturer are slim. While this point is not new it is pretty definitely substantiated by the engineer whose letter has been quoted. The most interesting thing about his communication, however, is the suggestion of American interests producing in France and importing into the United States.

What of the Public Safety in Pittsburgh?

Confronted with the duty of building for the community several new bridges over the Allegheny River, the commissioners of Allegheny County, which includes Pittsburgh, have turned over to architectural firms the work of designing and supervising the construction of two of these bridges. This matter was briefly adverted to in our Emergency Bulletin of Oct. 23, but the subject is of such importance as to call for fuller treatment than was then possible. Great engineering structures are in question. They will contain arch spans of steel up to 500 ft. in length. Problems that demand the highest engineering skill and most careful training in bridge design must be solved. It is these problems that have been entrusted with full authority to architects.

What of the public safety? The answer hinges undeniably on the question whether the work of designing bridges is within the proper field of the architect. The issue is not an academic one but goes to the root of things; public safety is the issue, and the question therefore needs to be urged very directly. Is the architect competent to design a large steel bridge or to direct its construction? If he is, surely the present-day science and art of engineering is a delusion and a mockery, and the endeavor of the engineering profession to combat engineering quackery by state regulation is as a stone cast into the water!

Time was, centuries past, when there were no engineers, and in those days not only bridge construction but also water supply and sewage disposal were dealt with by architects. Time was, also, when medicine was practiced by barbers. But the generations have progressed. Medicine has come into being as a great science. The engineer, the architect and the bridge of today are incomparably different from their predecessors of those early days. Today we have a medical profession and an engineering profession to deal with their respective sciences in practice. Power plants, bridges, cranes, and water-works are the objects of professional engineering work, as operations on wounds and treatment of disease are medical functions. Is it possible today that architects should attempt the construction of great bridges? The tonsorial artist who undertakes to treat the sick is thrown into prison, for he threatens the safety of the community!

As to the part of the Allegheny County commissioners in the matter we need not concern ourselves seriously. Political officialdom indulges in many queer actions; healthy local sentiment is the surest means of control. The engineers of Pittsburgh may be depended upon to stigmatize the commissioners' action and to make suitable protest. And if the law lays upon the commissioners a duty to see that public work of technical character is entrusted only to men properly qualified to deal with it, the people of Allegheny County will doubtless find the application of this law to the case in hand. For Engineering News-Record, however, the serious aspects of the situation lie on the professional side.

In the profession of architecture, sister profession to engineering, there is a well-developed professional conscience. And if the principles on which this is founded have merit, they surely include the rule that the architect shall not professionally undertake service that he is not qualified as an architect to perform. What then of the present case? Shall it be considered professional for an architect to barter this principle for six per cent by venturing upon work of pure engineering?

We ask what is the attitude of architects themselves as to this matter. In our view their professional honor is involved--and also, we would suggest, their good repute with the public and their relation of mutual respect and amity with the engineering profession. Do their tenets of practice discountenance the undertaking of work outside the scope of architecture? If they do, it may appear that professional principle has been violated in serious manner. But if they do not, the ethical foundations of the profession need revision.

Recent labors to bring about legal regulation of engineering practice are endowed with new significance in the light of the Pittsburgh case. In establishing definite professional recognition, such state regulation would -- this has been our hope--assure the public that works of engineering are undertaken only by men qualified as engineers through training and experience. The thought has been to protect the public against malpractice by engineers. A corollary to that is that the public needs to be protected against the malpractice of architects also.

It is no defense of the Pittsburgh procedure to say that the architects will employ competent engineers. The fundamental requirement is that the major responsibility must be in the hands of those technically competent to assume it. If it is not then the architects in question are acting merely as brokers.

The case is clean-cut and of such importance that at least four bodies should concern themselves with it. The Engineers' Society of Western Pennsylvania, the American Society of Civil Engineers, the American Institute of Consulting Engineers, and the American Institute of Architects. The issues need to be determined once for all.

Bridge Building and Warfare

In the war time work of bridging streams and hollows in order to carry rapidly-moving armies forward over the advance areas there resides a powerful stimulus to thought for the bridge engineer in civilian service. Remarkable similarities tie together his daily work with that of modern military bridging, and at the same time certain differences suggest reflection.

Chief among the latter are the range of structural classes necessary in field service, and the overshadowing importance of the two factors of weight economy and adaptability for very rapid construction. The ordinary requirements of peacetime work tend toward standardization on highly-elaborated types of bridge, with the result that the engineer of bridges is apt to relegate all less elaborate and non-standard forms to the realm of third-class or makeshift construction. Structural science, however, applies to them as fully as to the standard road or railway bridge, and there is no lack of opportunity for utilizing the refinements of engineering art in their design. Often, indeed, we may see an emergency bridge, as built after a flood washout or for service during renewal operations, embodying far higher skill and ingenuity of design than does the costly permanent bridge which follows it in service.

It will be a loss to the world if the profession of bridge engineers does not remain in full mastery of all the resources of its art. There is even now, perhaps, a tendency for collegiate instruction in the subject to ignore everything outside of standard construction, in order to serve practice more immediately. The tendency might well be reversed; for it is while the bridge engineer is acquiring his technical foundation--knowledge that he should become firmly grounded in the broadest possibilities of his science.

Seeking after maximum economy of material has become virtually a secondary objective in normal bridge design. Standardization of practice and the necessary predominance of robustness and permanence lead constantly in this direction. Yet the whole of the bridge-builder's art rests on most efficient utilization of material, in other words on weight-economy, and for this reason it has always appeared to us unfortunate that in practical bridgework structural efficiency should be treated as an academic matter. Truth is, we think, that every great achievement in the bridge field springs from a sound, deeply-rooted understanding of the ideals of structural efficiency. Let the bridge engineer come to realize that there is engineering of a high order in the simple trenchcrossing span; still more in footbridges; still more in ponton construction and (in more familiar form) in the main-road bridge of light weight, of great portability and of maximum adaptability to various emergency service-- and his field of thought is certain to be broadened. His civilian bridgework will be benefited, and in addition he or his successors will be better prepared to take up the burden of military bridging at any future time.

A revolutionary change in bridge operations came about during the war, and this is the outstanding feature of the summary of bridging experience which we are able to present in this issue. With one bound the range of the operations leaped beyond the confines of the soldier's manual or of rough-and ready method based on old equipment and mere ingenuity. It became a field for engineering. All that the war brought to the front in bridging was produced by virtue of the science and constructional procedure developed in civilian bridge-building work. So severe and suddenly shifting were the demands that only the experienced bridge engineer could meet them. To overlook the meaning of this transformation would be failure to grasp the full import of a weighty matter.

Why this transformation did not come about sooner is still obscure. A few crisp, cold facts in the situation are bound to form the background of reflections on the subject. A year after we entered the war, American troops in order to cross the Marne were forced to build a bridge of old gasoline cans, nothing else being planned or provided for them. Before 1917, war experiance had shown that service required a number of different types of bridge in the advance areas, and such types had been developed and were in use; but even long afterward our own bridge equipment was limited to one type, and this old equipment was not used by our forces. Our training camps taught the new men how to build a type of bridge that found no use whatever in the war, either before or afterward. A portable heavy-duty type of bridge was known to be needed for sustained offensive operations and had been developed by other armies, but the first American bridge of the kind was sent out of the maker's shop just nineteen months after we started to fight, and then was too late for use. Human lives hang on such matters as these.

It has often enough been emphasized that the warfare of today is the work of engineers, of specialists. But while we have readily thought of specialists in gunnery, in explosives, in motive power, in chemistry, we have not been willing to think of bridge specialists. Now, however, our thoughts are turned forcibly in this direction. If warfare needs bridge specialists, it means a thoroughgoing overturn in military engineering.

A most interesting fact of the matter is that loads and speeds were the key points of the war's new demands on bridges, as they had long been key points in civilian bridge work. For years during which the votaries of military academies were still summing up the bridge art in terms of traditional equipment and bounded their horizon with lumbering trains of parade-day fieldpieces, civilian engineers had been wrestling with the perplexities of steadily growing railway loads and the sudden burden of heavy and fast motor trucks overtaxing light highway bridges. This occupation gave a perspective that was needed in the war. The future military engineer must acquire a similar freedom and power of technical view.

Of immediate importance is the fact that the lesson of wartime bridging was left uncompleted. Aside from the problems of organization, spirit and scientific principle, there is the direct problem of carrying this lesson to its conclusion. At the time hostilities ended, planning was far from being finished, and provision of stocks of equipment had hardly been begun. But if bridges are as important as cannon, it is patent that they must be planned as far ahead, and that they must be on hand and ready at all times. There is important work to be done, then, work which we may hope is in progress at the present time.

Bridge Engineering in Active Warfare

Civilian Bridge-Design Methods Applied in Work of A. E. F. — Bridge Department Organized — Unprecedented Loadings — Traffic Conditions — New Types of Bridge Developed — Reinforced Pontons—Sectional Steel Bridges—Flooring, Loads, Impact and Unit Stresses

By Lewis E. Moore and Marshall W. McDonald
Formerly Major, Engineers, U. S. Army
Formerly Captain, Engineers, U. S. Army

IN MODERN warfare the motor truck, heavy artillery, and the 30-ton tank have conspired to render former types of military bridges wholly inadequate. The so-called spar-lock bridge, made of trees cut and lashed together, which was invented during the Peninsular campaign, early in the nineteenth century, and was carefully taught in its original form in the American training camps in 1917, has been displaced by the bolted sectional steel bridge. In both the British and the American Armies a new aspect was given to the subject of bridging by the introduction of what are in effect civilian bridge-engineering methods, and the virtual abandonment of the methods of the traditional military engineer, with respect to fixed bridges. One significant expression of this change was the organization of a bridge department. New types of equipment were developed, based on precise design to suit actual loadings.

As a result of the Army's work in bridging, experience was accumulated and certain standards were established that are likely to be of determining value ni future military bridge operations. The field practice strongly emphasized the necessity of our Army's having on hand at all times an ample stock of steel and ponton bridge material and of training the troops in using this material; when the war broke out we had none but a small amount of ponton material, and this was not used, and even after 1½ years of participation in the war we had no modern steel bridge material ready for use. Still more strongly, however, did it emphasize the need of providing construction equipment, such as portable piledrivers, A-frame derricks, and a proper complement of suitable tackle, gasoline hoists, and the like.

Organization of the Bridge Work

Because the military bridge differs essentially from the bridge of civil life, in that it must be erected with great rapidity, *always without falsework*, must be simple, must be made of parts small and light enough to be easily transported in Army trucks, must use readily available material, and must be built with a minimum of tools and equipment, it has in the past been dealt with by military engineers and its construction has been treated as a subject wholly apart from civil bridge engineering. But in the present war the new and very severe load conditions called for a different manner of treating the problem. The ponderous motor trucks traveling at high speed which replace the former Army supply carts, and the heavy mobile artillery and tanks of the present time, require bridges that are in every sense true engineering structures. Empirical methods of bridging could no longer be depended on. It was for this reason that a bridge department was organized by the A. E. F. at an early stage.

To trace the history of this department in detail seems unnecessary. It began with two officers only, a regular and a reserve, and gradually evolved toward the following: An officer in general charge, whose duty was to see that standards were prepared and that material was on hand and so placed as to be readily available with a minimum of transportation; a bridge officer with each Army, who had charge of all fixed bridge work, including design, construction and maintenance; a variable

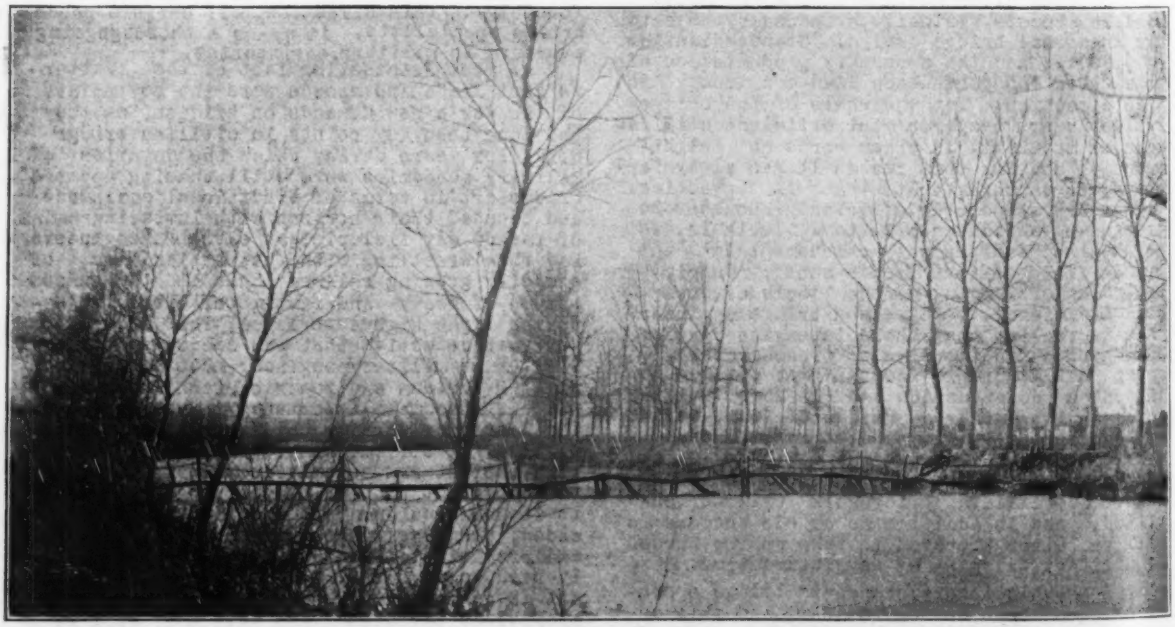


FIG. 1. A NECESSARY TYPE OF MILITARY BRIDGE—FOOTBRIDGE FOR INFANTRY ADVANCE OVER MEUSE RIVER NORTH OF VERDUN
Built under gun fire, by divisional engineer troops; length, 120 feet.

number of troops and certain construction equipment assigned to the Army bridge officer according to his needs.

It must be understood that this organization was worked out in its entirety with the First Army only, and that the construction of ponton, foot and trench bridges remained with the divisional engineer regiments.

Initially the function of this department was to design standard structures. Because of the requirements of the work and Amry necessities, it functioned largely through engineer officers commissioned from civil life, who used civilian bridge-engineering methods. It should be said that railway bridge problems, which are closely similar to those met in emergency railroad bridge work in civil life, were handled by other agencies.

When the United States entered the war, the divisional engineer troops were relied upon to design as well as construct and reinforce bridges, in addition to their other work. Beyond a small amount of ponton equipment in the United States, there was no bridge material on hand, and no adequate designs had been prepared. But in September, 1917, the development of bridge equipment and standards was commenced both in Washington and in the A. E. F. The work was finally completed in the American Expeditionary Forces.

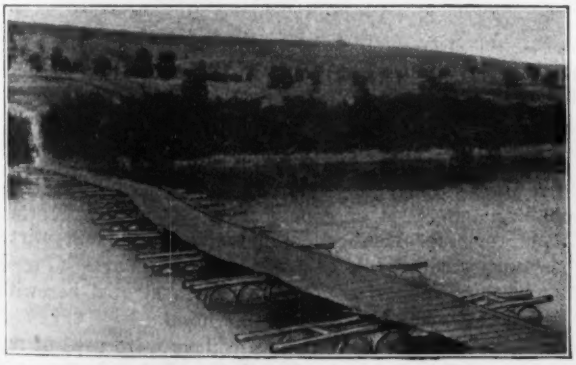
From the commencement of the war in 1914 down to its end in 1918, the character and amount of traffic, and therewith the weight of the heaviest loads, steadily increased so that continuously stronger and more stable bridges were called for. The British revised their standards upward at least five times during this period. From the very first, therefore, the American Army had to meet conditions very greatly different from those contemplated by pre-war methods and equipment.

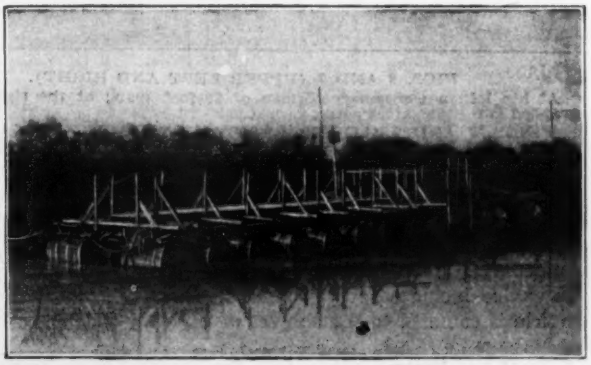
The quantity of supplies of all sorts required, and the high rate of consumption during active operations, are almost incomprehensible. During the attack on Verdun in 1916 the traffic on the Bar-le-Duc-Verdun road was more than 5000 vehicles per day in both directions, for over three months. During the battle of the Somme, in the same year, on the Amiens-Braye-Maricourt-Cappe road, a regular daily movement of 5000 vehicles was recorded, while on days when the troops were being relieved up to 17,000 were counted. Both of the above roads were 8 to 10 m. wide and carried three and four lines of traffic. During the Meuse-Argonne offensive in 1918 the traffic passing Varennes on a road carrying two lines of traffic was 4000 vehicles per day.

During the operations of the past year, a controlling factor often was the inability to restore quickly the lines of communication, rather than the ability of the enemy to resist attack. Transportation was often delayed, if not entirely stopped, by the condition of the roads and bridges. The lack of bridges sometimes interfered seriously with operations. Since bridges are usually the most vital and the most easily destroyed links in a line of communication, they are destroyed in retreat and must be quickly restored in case of an advance; their importance is more vitally felt when they are absent than when they are present. But besides the mere

FIGS. 2 AND 3. TYPICAL BRIDGING CONDITIONS ENCOUNTERED BY THE ARMIES IN FRANCE

At the location shown at the left, four bridges were built successively; a steel peace-time bridge was demolished by the retreating army; the replacement trestle, intended for light artillery only, was broken down when a tank tried to run over it; another trestle, built on top of the wrecked tank, was destroyed by the enemy; finally a steel demountable truss span of 72 feet was placed. The view at the right shows a typical mine crater in a road, one of the frequent and troublesome problems in an advance.





FIGS. 4 AND 5. TWO TYPICAL INSTANCES OF BRIDGE IMPROVISATION

Gasoline-can footbridge over the Marne, built for the counterattack of July 18; at the right a French cask-float footbridge over the canal at Dieue-sur-Meuse, for infantry

presence of a bridge, its traffic capacity is a momentous factor, and a one-way bridge on a two-way road, for example, throttles operations seriously. With the intense concentration of men and materials of modern military operations, an unusually large number of bridges is required in order to give adequate capacity. There were many instances when three or four bridges side by side had to be provided.

Some idea of the number of bridges involved may be gained from the following: Over the Meuse River between Verdun and St. Mihiel, approximately 33 km., the French constructed 23 crossings for wheeled traffic and 47 crossings for infantry. Between March and December, 1918, inclusive, the British Army erected 562 highway bridges. The American First Army built nearly a mile of bridges during the Meuse-Argonne offensive and immediately afterward, as the following table indicates. The table includes railway bridges, though the present article is confined to the subject of highway bridges.

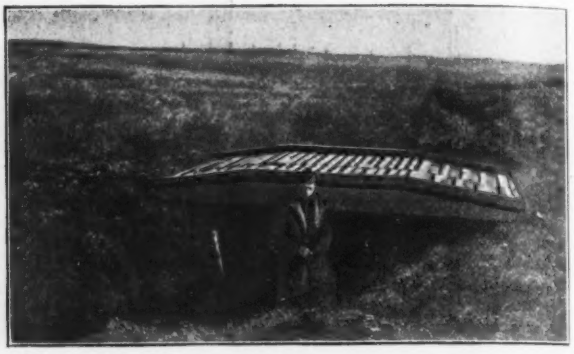
	Number of Bridges	Lineal Feet of Bridging—Strengthened	Widened	New Framed Trestle	New Pile	New A-Frame	Trestle on Piles
Highway	40	1329	95	662	400	120	90
Standard-gage	12	230	..	305	186	...	..
60-cm. gage	12	330	..	276	195	...	..
Totals	64	1889	95	1243	781	120	90

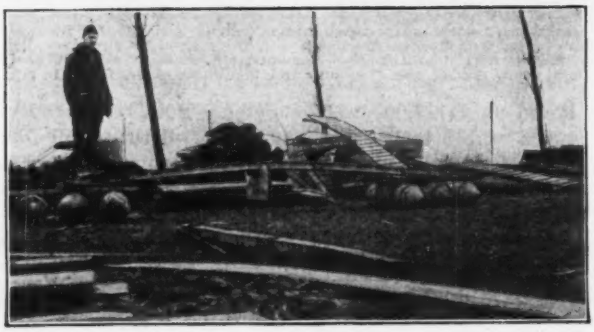
During an advance several bridges may have to be built at the same crossing: usually first a light footbridge for infantry, followed by a ponton bridge, and this in turn by a more permanent bridge of available material; and, finally, a demountable or sectional steel bridge or a timber crossing capable of carrying the heaviest loads. For very dense traffic a second span alongside the first may be required. Where bridges are apt to be shelled, a second bridge is sometimes built a little to one side, to be used when the other is under fire or is damaged. The best general rule, it may be stated from experience, is to build in the first place a bridge capable of carrying the heaviest traffic, when conditions permit; this conserves both labor and material.

So much for the general conditions of the service. The bridge department's work was necessarily varied. Its results, and the associated experiences and parts, are most easily and usefully stated by referring to the different types of bridge separately.

FOOTBRIDGES

Footbridges, used principally to enable infantry to pass an obstacle during an attack, and often built under fire, make the highest demands as to portability, simplicity and speed of construction. They are a prime field for improvisation. Lieutenant Colonel Stewart's famous gasoline-can bridge across the Marne (Fig.4) and other improvised footbridges illustrated herewith bring this graphically before the mind.





FIGS. 6 AND 7 (UPPER LEFT AND RIGHT). DIFFERENT USES OF PORTABLE TRENCH BRIDGES
At hte left, a German footbridge of 20-foot span; at the right, a British artillery bridge over a trench on Vimy Ridge, photographed two years after active operations

FIGS. 8 AND 9 (LOWER LEFT AND RIGHT). GERMAN FOOT PONTON AND LAMPERT FOOT PONTON
At the left, steel cylinder float easily penetrated by rifle balls; bulk hampers transportation; at the right; bridge over Meuse near Mouzon, placed under machine-gun fire in 30 minutes by troops who had never seen it before

Both fixed and floating footbridges were used of numerous different types. It is believed that in future it may be necessary to make them wide enough to carry the various infantry weapons, such as trench mortars, machine guns and 37-mm. guns, which accompany the infantry in an attack. Some of the varieties of footbridge are illustrated in the views herewith; the A-frame, framed trestle, pile and common beam bridges are so well known as to need no special comment. In many instances the débris of a demolished bridge served for a crossing, especially in the case of demolished truss bridges.

Light pile or stake bridges, much lighter than the pile bridges later mentioned, were used extensively for crossing streams and marshes; the French in particular

used a great many. Such structures usually consisted of two-pile bents with batter piles, cross-braced. All driving was done by hand mauls. Their bridges had a width of 1.8 m. in the clear, enough for machine-gun carriages as well as infantry.

Lampert Ponton—Foot ponton bridges did not exist in the American Army when it entered the war, but all the other combatants had developed such devices or their equivalent. The late Lieut. Col. J. G. B. Lampert developed a foot ponton that surpasses all others in ease and speed of erection, as well as in compactness for transport. This ponton consists of a wooden collapsible frame 6 ft. 5½ in. x 3 ft. x 18 in. deep, covered with canvas. A light gangway is laid across from ponton to ponton. This type was manufactured only just previous to the beginning of the Meuse-Argonne drive. In that advance a number of these bridges were erected by the engineers and they proved entirely satisfactory (see Fig. 9). A type of foot ponton using cork rafts as supports was developed by the Canadians (see sketch in Plate II). The cork floats are unsinkable under machine-gun fire, and when once laid are always ready for use, unless destroyed by a direct hit from a shell. The choice of the best foot ponton seems to lie between the cork-float ponton, on account of its reliability, and the canvas ponton of Lieutenant Colonel Lampert, on account of its portability. The two are about equal in ease and speed of erection.

Steel Pontons—A very different type of foot ponton (Fig. 8) was extensively used by the Germans. While good in many respects, it is undesirably bulky for transport and is easily sunk by rifle or machine-gun fire.

Canvas Fords—In connection with footbridges, the method frequently used by the French to ford a stream having mud or shell holes, or both, in the bottom deserves mention. Many small streams could not be forded because the men sank in the mud and shell holes and drowned. To get across safely a canvas carpet reinforced with chickenwire was then used. Ropes at one end of the carpet were fastened to two stakes driven on the near bank; then one man unrolled the carpet across the stream bed, walking upon it as he unrolled it. After reaching the far shore he fastened the end to stakes on that side also.

Trench Bridges for Foot and Artillery

All the combatant armies except the American were equipped with portable footbridges (Fig. 6) carried by the attacking troops to cross trenches, wire entanglements and streams. Our Army, like the others, developed short-span portable bridges on which guns

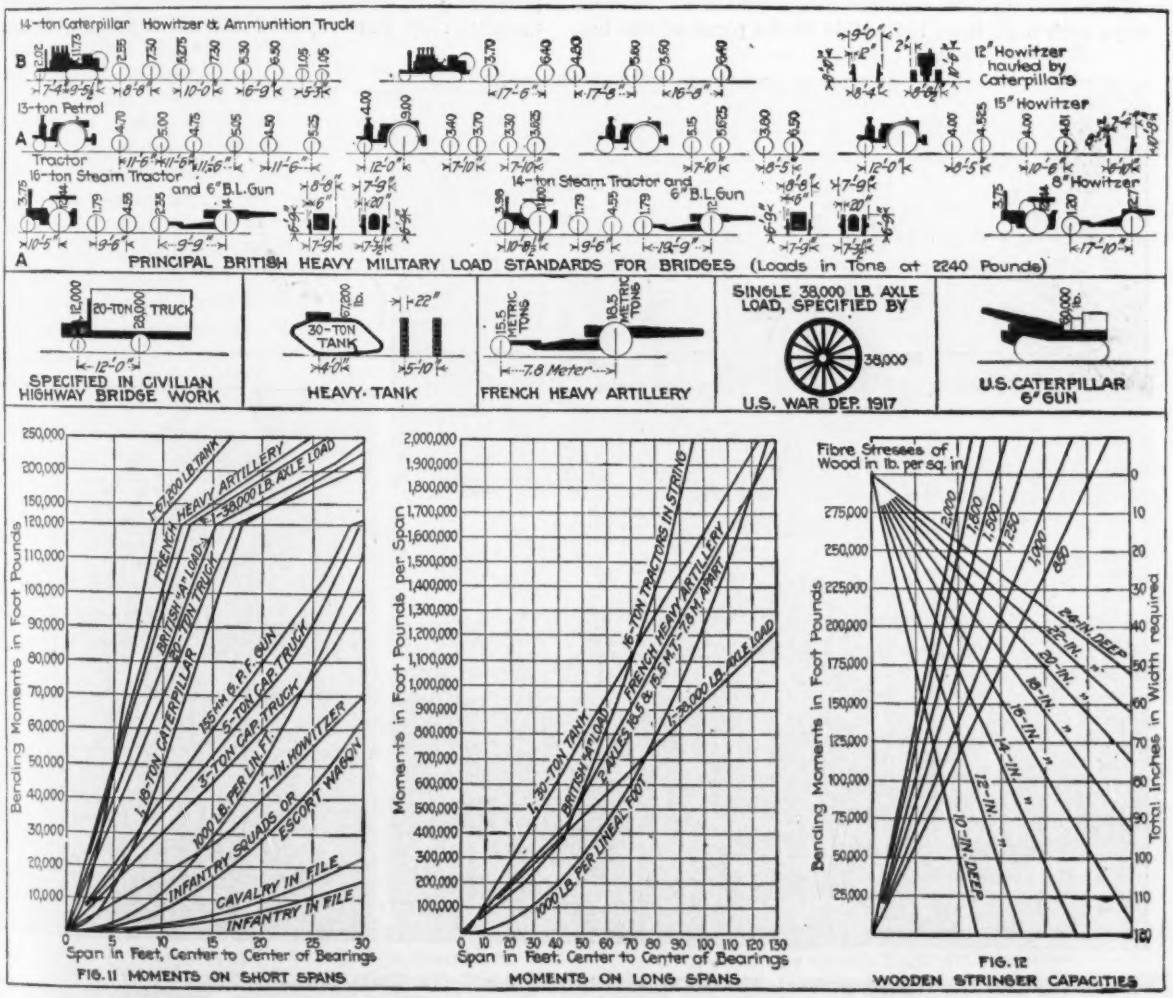

14-ton Caterpillar Howitzer & Ammunition Truck
13-ton Petrol Tractor
16-ton Steam Tractor and 6" B.L. Gun
14-ton Steam Tractor and 6" B.L. Gun
12" Howitzer hauled by Caterpillars
15" Howitzer
8" Howitzer
PRINCIPAL BRITISH HEAVY MILITARY LOAD STANDARDS FOR BRIDGES (Loads in Tons at 2240 Pounds)
20-TON TRUCK
SPECIFIED IN CIVILIAN HIGHWAY BRIDGE WORK
30-TON TANK
HEAVY TANK
FRENCH HEAVY ARTILLERY
SINGLE 38,000 LB. AXLE LOAD, SPECIFIED BY
U.S. WAR DEP. 1917
U.S. CATERPILLAR 6" GUN
Bending Moments in Foot Pounds
Span in Feet, Center to Center of Bearings
FIG. 11 MOMENTS ON SHORT SPANS
Moments in Foot Pounds per Span
Span in Feet, Center to Center of Bearings
MOMENTS ON LONG SPANS
Fibre Stresses of Wood in lb. per sq. in.
Bending Moments in Foot Pounds
Total Inches in Width required
FIG. 12 WOODEN STRINGER CAPACITIES

PLATE I—MODERN MILITARY BRIDGE LOADINGS AS DEVELOPED DURING THE WAR AND SUBSEQUENTLY
Typical moment curves and a diagram for proportioning wooden stringers are given below theloading diagram

would cross trenches (Fig. 7) in following up a drive over the trench systems of the war of position; these were long enough to span the ordinary trench or small hell hole and strong enough to carry the field guns. They were made in two longitudinal duplicate halves, to facilitate handling and were carried on gun carriages and limbers during an advance. A typical example is sketched in Plate II; this is as good as any of those used. In open warefare it is of course not necessary to supply such bridges.

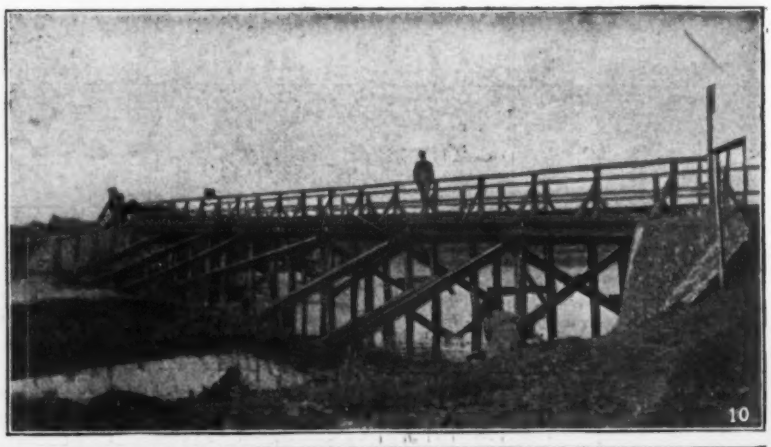
The foot and artillery bridges are closely similar, being beam structures with transverse planking, designed for utmost lightness and strength. Trussed sticks were often used as the carrying members, to secure these objects, as in the German footbridge shown by the view, Fig. 6.

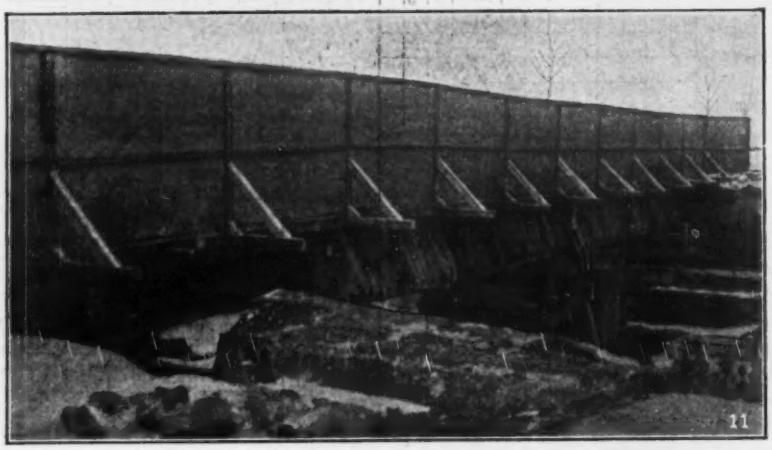
"Inglis Light" Footbridge—Shortly before the war a peculiar type of truss bridge, made of pipe sections, was developed by a British professor named Inglis. After its successful trial the British Government asked him to design one for highway loads; this is described farther on. The original light type of structure was used by the British Army to some extent, during the war, for footbridges.

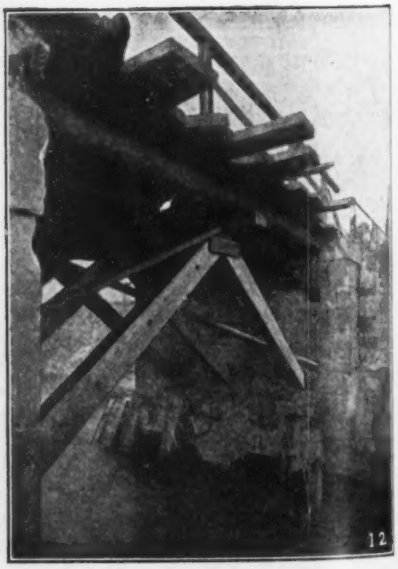
The "Inglis Light" is triangular in cross-section (Plate III) and is composed of a series of identical bays each 8 ft. long, 8 ft. wide in the plane of the bottom chord, and 8 ft. high. It is intended to carry infantry in file over a 96-ft. gap. It should be noted that there is only one top chord. The members are drawn-steel tubes connected by junction boxes of steel castings. It is claimed that a trained crew can erect a bay in 60 sec. The bridge is launched over a pair of steel wheels, a temporary balancing arm having been built at the tail of the bridge. It is shoved forward across the gap or swung sidewise on the wheels as a pivot, and the balancing arm is then removed. There is a case on record of a 110-ft. span being thrown across in 11 min. by a green crew under school conditions. The type has been very useful, especially in crossing canals or streams with high, steep banks, where the approaches to a ponton bridge would be difficult.

Ponton Bridges for Modern Loadings

For many decades the most important type of military bridge, the ponton type retains a position of great though somewhat lessened importance in the light of the past war's experiences. Old ponton equipments, both American and allied, proved inadequate for the continuous service demanded of modern military bridges and inadequate to carry the heaviest loads. Reinforced types were constructed to carry moderately heavy artillery (but not the heaviest, or tanks); yet even so, practically no ponton bridges were left in service permanently, but were replaced as soon as possible by some

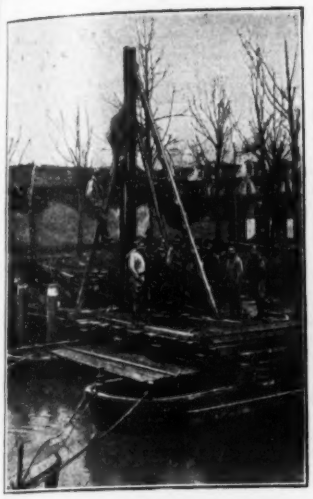


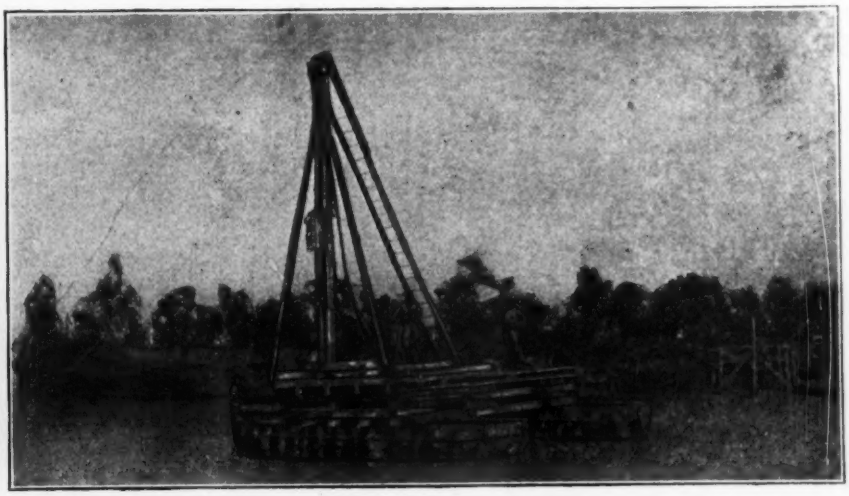




FIGS. 10 TO 12. THREE SPECIAL FEATURES F TIMBER BRIDGE CONSTRUCTION ON THE FRENCH FRONT

Fig. 10—Ice breakers on a French bridge over the Meurthe near Nancy, illustrating an occasional requirement in military bridging; Fig. 11—Built-up wooden girder bridge over canal near Turcoing, built by Australians; the upper part is a shelter fence; Fig. 12—Hurriedly built bridge at Consenvoye, 22-foot span





FIGS. 13 AND 14. MILITARY HANDPOWER PILEDRIVERS USED BY EUROPEAN ARMIES; CAN DRIVE ABOUT ONE PILE PER HOUR

Fig. 13—French demountable, used on Oise near La Fère; Fig. 14—German demountable, used by United States Sixth Engineers on Marne

other form of structure.

None of the American ponton equipment was received at the front in France during active hostilities. Our troops built all their ponton bridges with French or German equipment. They constructed several across the Marne River in July, 1918, and across the Meuse in November with German equipment captured along the Marne near Chateau Thierry.

When the various combatants found that their old ponton equipment was inadequate, they increased the floating power by using two pontons for each support, and strengthened the floor by using additional balk (stringers), a double layer of chess (planking) and a reinforcing balk as side rails. In some instances still further increase of strength was obtained by placing the supports closer together and using steel I-beams as balk. As already stated, however, all these reinforced ponton bridges were still inadequate for heavy artillery and for tanks.

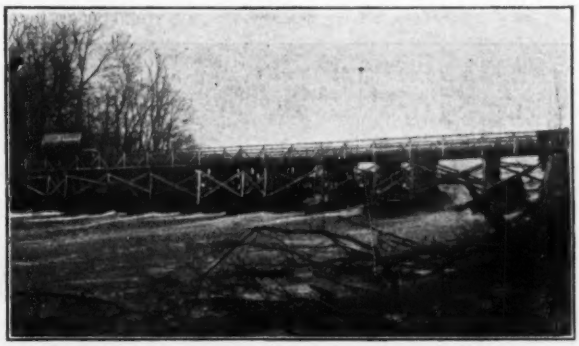
Since the American standard ponton has an effective buoyancy of something less than nine tons, the greatest concentration that can be carried does not much exceed 15 tons. In view of the very much heavier loadings of modern warfare, stated more specifically farther on, it seems an important future necessity that ponton equipment be designed and provided capable of adaptation to these loadings.

Pile and Trestle Bridges

Pile and framed bent trestles will doubtless always be the principal reliance for military bridging, as they were in France. They are easily constructed, and the material required is more generally available than that for any other type of military bridge. Except for proportioning parts for the loads to be carried and to the construction equipment at hand, the practice on the front in France was closely parallel to our civilian bridge practice and needs but few further remarks.

Piledriving—Piledriving equipment was necessarily scarce, and the American Army, in fact, had none, except what it improvised in the field, captured or borrowed. No piling could be contemplated anywhere that required a hammer heavier than 1000 lb., and, generally speaking, the use of handpower or other light drivers had to be counted on.

Difficulty in driving was nowhere a factor. Along the Aire and Meuse River it was at first thought that it would be impracticable to drive piles, on account of the gravel and small stone. Examination showed that the layer of gravel was only 2 to 4 ft. thick, below which was a layer of 4 to 7 ft. of blue clay over gravel and stone, so that it was only moderately difficult to drive piles, and a good footing could be obtained. Along the



FIGS. 15 AND 16. TWO-WAY TRESTLE FOR HEAVY ARTILLERY AND DOUBLE PILE BENTS WITH CROSS-CAPS OFTEN USED BY GERMANS

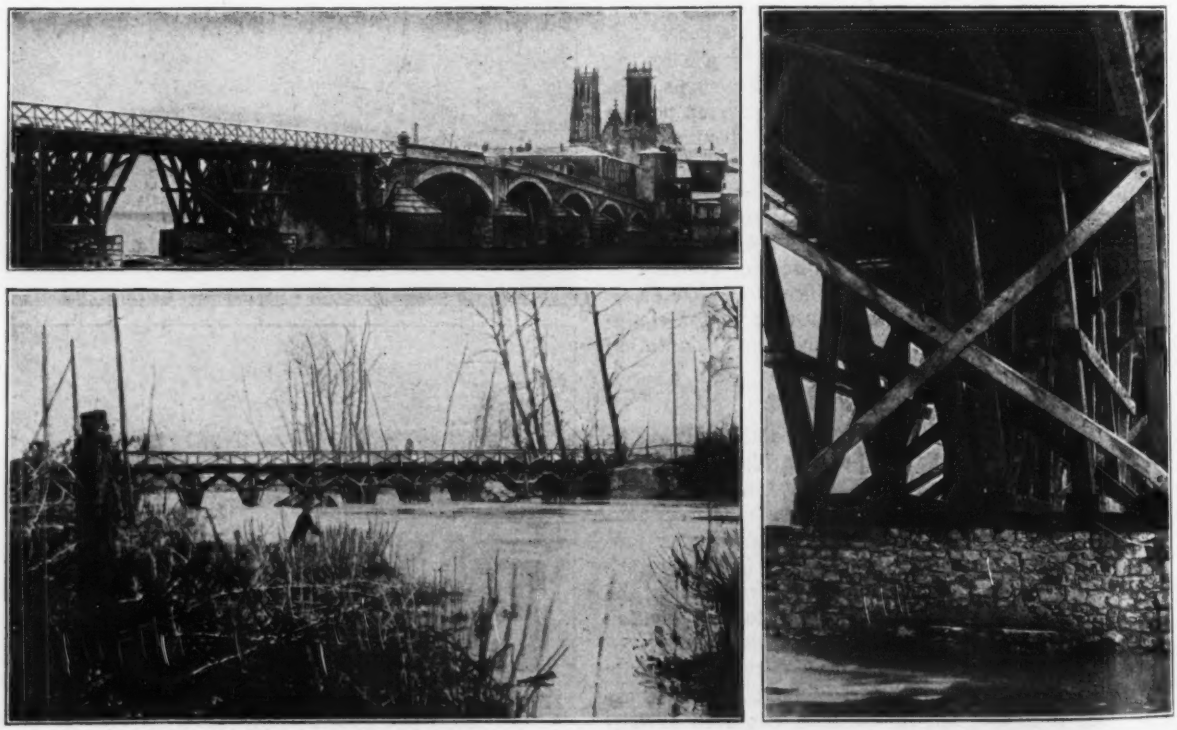
Fig. 15—Built by Americans at Stenay, Meuse River; spans varied to suit footing on old masonry and river bed; Fig. 16—Bridge over Meuse near Consenvoye; far half American

FIG. 17. FRAMED TRESTLE USING ROUND TIMBERS
Built in eight hours by United States engineer troops—Vesle River bridge near Bazouches, September 7, 1918.

Somme and on the Flanders front there were no beds of gravel; the soil was all clay or chalk.

The French used piles to a large extent. In fact, there are more bridges of this type than any other within their zone. Their standard practice was to use the girder cap, gaining both sides of the pile and bolting a light cap on either side. This consumes time and requires much hand labor. The American and British practice was to use a single rider cap, sawing the piles off level and driftbolting the cap into place on top of the piles. Another common practice with the French was to bolt two stringers together, sometimes with an I-beam between. Their timber bridges were fitted with walks on either side, a very advantageous feature, as men can cross readily without becoming involved with roadway traffic.

Framed Bents—On account of the delay entailed by driving piles in any event, framed-bent trestles were used wherever possible by the American troops. In the French rivers, where danger of scour is rare, this practice unquestionably justified itself. Nevertheless, it should be remarked that the French and also the Germans relied much more on pile than on framed-bent bridges.



FIGS. 18 TO 20. ARCHLIKE STRUTTING IN FRENCH AND ITALIAN BRIDGES
Upper picture shows French bridge over Moselle at Pont-à-Mousson, and at right a pier detail of the timberwork; below, an Italian strutted-beam trestle of archlike character over the Aisne River near Chateau Porcien, ten spans of five meters

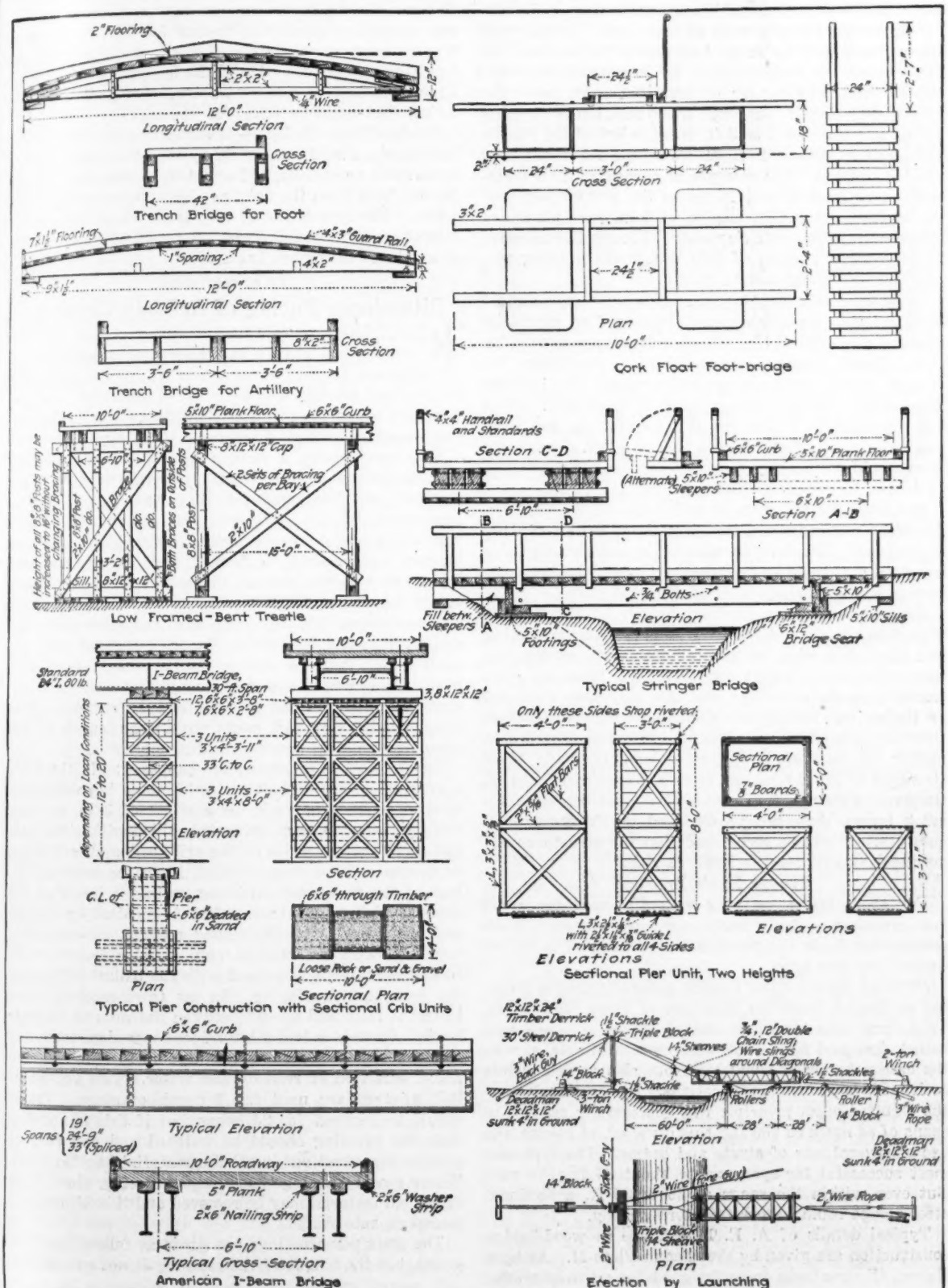


PLATE II—MODERN MILITARY BRIDGING PRACTICE—TRENCH BRIDGES; CORK FLOAT FOOTBRIDGE; STRINGER AND FRAMED-BENT BRIDGES; THE NEW SECTIONAL PIER (AMERICAN DESIGN); AMERICAN STANDARD I-BEAM BRIDGE TO CARRY HEAVY TANKS; LAUNCHING METHOD OF ERECTION

Conditions along the American front were in general quite favorable to framed-bent construction, and most of the timber bridges were of this type. It was used where there was no scour and where the bottom was firm enough (or could be made so) to support the bents. Where there was danger of scour, in some cases the framed-bent construction was made suitable by digging a foundation trench 2 or 3 ft. into the bed of the stream and placing mudsills in it, on which the sill of the bent was then placed. For example, at Griscourt the foundations were from 2 to 4 ft. below the stream bed, and the mudsills were 3-ft. lengths of 5-in. road planking; this was in rather soft clay soil. Through the meadow, in the central portion of this bridge there being two channels, no mudsills were used.

Bridges of considerable size of this construction could be built before a piledriver could be rigged up, especially where it was difficult to get a piledriver up to the bridge site. Canal crossings presented ideal conditions for framed bents, especially at locks, where the bottoms were paved. Again, when a stone or brick arch bridge was demolished it was usually possible to get good footings on top of the débris, though often a moderate flood would wash away enough of the smaller particles of débris, to undermine the supports.

Not until the last days of active operations could the American engineers secure any standard bridge timbers at the front; therefore, in most of the bridges, anything was used that could be procured, and often similar members in a given bridge were of different sizes.

Framed bents were used extensively by the British, with both timber and I-beam stringers. Their framing was much like what we are familiar with, except that they relied more on dogs for fastenings; these are mentioned separately farther on. As they also depended on timber and usually on framed-bent trestle construction for their railway bridges, it may be remarked as a matter of interest that they commonly made their stringers of 10 x 20-in., and posts and caps of 14 x 14-in. timbers. This was imported timber, and the sizes are much larger than can be obtained in France in any quantity. It will be recognized that the structures are needlessly heavy for the loads carried.

Timber Beam Bridges

For short spans—as very generally used for canal lock crossings—simple beam spans were used. With present-day loads the possible length of span is rather limited for this type.

Strutted Beams—The French generally used a strutted or braced beam for openings of more than 16 ft. This form was especially useful where the gap was rather deep and rigid abutments were available, as was the case not only at canal locks but also at demolished arch bridges and similar locations. In occasional cases the strutted-beam principle was successfully applied to spans of as much as 100 ft.; this involved, of course, the use of several sets of struts and beams. The type was most successful for spans up to about 35 ft. (11 m.). But even within the range of 30 to 35 ft. a sectional steel bridge could be erected more quickly.

Typical details of A. E. F. practice in wood-bridge construction are given by sketches in Plate II. As here shown, all structures were designed for one-way traffic. For two-way traffic two bridges were built side by side or the bents built wider than shown.

Approximately 2½ miles of bridging materials for standard timber-bridge construction, with caps and sills all bored for driftbolts, was on hand at Is-sur-Tille and was shipped to Abainville during October, 1918. Due to circumstances, very little of this material reached the front in time to be used, and the bridges of the Meuse-Argonne offensive had to be constructed of any materials that could be found on the spot.

Timber-Truss Bridges—Wooden trusses were very little used. The American Army used none whatever in its advance operations, and only two or three in its work farther back from the fighting area. Other armies built a few. The type is not of very much value, because of difficulties of fabrication and the practical impossibility of obtaining the proper hardware.

To be continued

Bituminous Paving of Railway Crossings

REDUCTION in cost and maintenance of railway crossings of streets and highways, together with conservation in the consumption of lumber and less liability of heaving of the roadbed by frost, are advantages urged for the use of oiled stone and bituminous macadam instead of the usual planking.

This construction is recommended in a committee report presented at the annual meeting of the Roadmasters' and Maintenance-of-Way Association, in Chicago, Sept, 16—18. It is estimated roughly that highway crossings represent about 76,800,000 ft. b.m. of lumber, independent of street and farm crossings. Preparatory to the paving, the ballast must be cleaned out to 2 in. below the bottom of ties for the full width of the crossing and 2 ft. outside of the outer rails; the rail jonts are to be bonded, the rails painted with asphalt under the base and up to the underside of rail head; tie renewals and drainage are to receive attention, and the track put in good line and surface. It is recommended that rail joints within the length of the crossing should be eliminated if possible.

Three methods of paving are proposed: In the first, a mixture of hot asphalt and ½-in. stone is packed and tamped around the rails for a width of 8 in. on each side, the interior space being then filled with stone ballast up to the underside of the rail head, and well rolled or tamped. Fine stone is filled in to the level of the tops of the rails, road oil being sprinkled freely as the stone is placed, and the surface is finished by rolling and sprinkling. By the second method, the asphaltic mixture along the rails is only 4 in. wide, while bituminous material is poured with the ballast filling and the ½-in. stone surfacing. In the third method, stone ballast is filled and packed between the rails up to their heads. On this is laid a bituminous macadam composed of clean gravel or stone screenings up to ½-in. size and a 2:1 emulsion of road oil and water. Two gallons of this mixture are used for 1 cu.yd. of stone. Traffic should be kept off for 24 hours, but if this is not possible the crossing should be watched and any ruts or patches smoothed out, until the material has hardened. Where paved crossings need only surfacing, about 2 in. of the old material may be removed and this bituminous macadam substituted.

The costs per crossings are given as follows, at 1918 prices, but the length of the crossing is not specified:

	Double-Track Crossing	Single-Track Crossing
1. Stone and road oil	$25.45	$11.95
2. Stone and bituminous	16.25	6.55
3. Stone and bituminous macadam	29.45	13.95
4. Planking	56.00	25.00

Economics of Railway Maintenance and Track Labor

Higher Pay and Permanent Employment Secure Better Men and Better Work—Wider Use of Machinery—Budget System

RAILWAY-MAINTENANCE work will benefit materially from the increased wages of section foremen and laborers, for under the new conditions it will be possible to attract and hold men of a higher grade. But with such an improved force, permanent instead of seasonal employment is highly desirable, while better housing and living conditions are imperative. Increased unit cost of labor will be an added inducement for the wider use of labor-saving appliances of a class that can be entrusted safely to men of the grade that may now be employed. This summarizes the opinions expressed by Charles A. Morse, chief engineer of the Chicago, Rock Island & Pacific R.R., in an address at the recent convention of the Roadmasters' and Maintenance-of-Way Association, in Chicago.

With the low wages formerly paid to section men, the railways obtained the poorest class of labor, except in the country districts, while a large proportion were foreigners who could not speak English. As they came to understand the work and the language, they drifted into other employment that offered higher pay, with the result that track labor was always more or less inefficient and afforded little material from which to select foremen. Mr. Morse considers it a good thing that changes must come under present conditions, as they will result in advantage to the railways as well as the men.

A budget system for each roadmaster's division, and subdivided for the foreman's sections, was advocated by Mr. Morse. This should cover the expense for four classes of work: (1) Minimum organization to maintain track, not including tie renewals; (2) additional seasonal help for mowing right-of-way and renewing ties; (3) additional help for improvements that will cheapen future maintenance cost, such as widening cuts and fills and cutting ditches; (4) exceptional expense due to storms, wrecks and snow removal. This last item should be based on average expenses for this class of work during the past five years, but revised to suit present prices of labor and materials.

The economic value of treated ties was also discussed, showing that they effect savings in three ways: In cost of material, in cost of renewals and in the lessened disturbance of track by renewals.

Concerning permanent employment of track men, Mr. Morse pointed out its advantages in keeping men who are skilled in the work and in attracting a better class of men who are looking for an opportunity to establish homes. Four men throughout the year will cost no more than two men for six months and six men for two months, and probably the track will be kept in better condition by the permanent gang. The former practice of employing large, temporary, extra gangs for occasional and special work was due to both the cheapness and inefficiency of the labor obtainable. Much work, such as the relaying of rails, can be done through the winter by grouping two or more section gangs, the general use of motor cars making this practicable without much loss of time. With rail-laying machines, ballast-distributing cars, ditching machines and similar appliances, the necessity for very large gangs will be eliminated to a considerable extent.

Finally, Mr. Morse urged the advantage of inducing and encouraging men to save a part of their earnings, a practice which will benefit not only the men themselves but the community and the nation. He recommended particularly the use of building and loan associations for their investments; associations of this kind have been established by some railroads for this particular purpose.

The Michigan Engineers' Registration Law

BETWEEN now and Jan. 1, 1920, engineers and surveyors wishing to practice in Michigan will have to satisfy the recently created state examining board that they have the requisite qualifications, as provided by the new registration law.

After Mar. 1, 1920, neither the state nor any of its minor civil divisions may construct or maintain public works for which plans, specifications and estimates have not been made by a registered architect or engineer, and no city or village plot shall be received for record that has not been prepared and signed by a registered engineer and surveyor.

Engineers and surveyors now practicing in Michigan, if citizens of that state, can readily secure certificates up to Jan. 1 on the basis of their existing status, but the case is so different for nonresidents that they may wish to look into the matter well in advance. They will be primarily concerned with Sec. 13 and 14, but for their convenience other sections bearing on registration are also quoted below:

1. Any person who represents himself to be an architect or as an engineer, or as a surveyor in any of the branches hereinafter mentioned, in the State of Michigan, shall be registered as hereinafter provided. Nothing in this act shall be construed to prevent any person, firm or corporation from preparing plans and specifications for buildings to be erected by themselves.

2. Any person who shall have been qualified in this state to use the title "registered architect" before this act takes effect shall be considered as registered under this act. Any citizen of the State of Michigan who shall have been engaged as an engineer or surveyor as a principal, or in the responsible charge or design or supervision of engineering works for not less than two years before this act goes into effect, shall be granted a certificate authorizing him to use the title of the branch of engineering in which he has been so engaged.

13. Any citizen of the United States of legal age and of good moral character, who has had not less than six years of practical experience in architectural or engineering work or surveying under the direction or supervision of a registered architect or a registered engineer or a registered surveyor, or of an architect or engineer or surveyor of equivalent professional standing, or who is a graduate in architecture or engineering of a college or school of recognized standing, and who has had not less than two years of such experience under like conditions, who desires to begin the practice of architecture or engineering or surveying as a principal or in responsible charge of such work, may, upon the payment of a fee of $5, apply for examination for a certificate under this act, and before receiving such certificate shall satisfactorily pass an examination in the English language and in such other appropriate subjects as are established by the board, and satisfy it as to his practical experience and general standing and ability; and shall pay the fee hereinafter provided for the certificate of registration. Provided, that time spent as a student of architecture or engineering in a college or school of recognized

standing shall be considered the equivalent of an equal amount of practical experience.

14. The board shall register architects and engineers of other states and of foreign countries to engage as principals, in the practice of architecture and engineering within the State of Michigan, when they are recognized as consulting specialists in some branch of their profession and have had at least 10 years of experience as such, or when they present credentials showing that they have qualified for such work under equivalent laws of their own states or Governments and are still in good standing thereunder. Provided, that such laws extend similar privileges to registrants under this act.

19. After Mar. 1, 1920, neither the state, nor any county, township, municipality or village, shall engage in the construction or maintenance of any public work of an architectural or engineering character, for which construction or maintenance the plans, specifications and estimates shall not have been prepared by a registered architect or a registered engineer under this act with qualifications appertaining to such work and the construction of which is not supervised by such a registered architect or registered engineer. Provided, that nothing in this section shall be held to apply to items of maintenance, repair or construction wherein the contemplated expenditure for the completed project does not exceed $2000.

20. After Mar. 1, 1920, no city or village plat, or plat of an addition thereto or of a subdivision thereof, or any plat dividing land into streets, lots or blocks, shall be received for record, which has not been prepared by a registered engineer or a registered surveyor and signed by him as such.

Pile Foundations for Unequal Load Distribution

Design Based Upon Analysis to Insure That Each Pile Will Sustain the Same Total Safe Load by Proper Spacing

BY EDWIN P. ARNESON
Irrigation and Structural Engineer, Washington, D. C.

THE typical retaining wall or dam delivers to its foundation a resultant falling in the vicinity of the outer third point of its base, causing unit pressures on the latter varying from 0 or more at the heel to twice the average unit pressure or less at the toe. When such structures are supported on piles it is essential that the latter be located so that each may take no more than its specified safe load. The formula and method which follow will facilitate accurate and rapid designing of pile foundations of this class.

In Fig. 1, let d be the base width of the wall, S_1

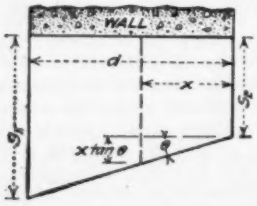


FIG. 1. TRAPEZOID OF PRESSURE

the unit pressure at the heel and S_2 the unit pressure at the toe, due to forces acting on the wall throughout a length equal to the distance center to center of pile bents or rows. Thus is defined the well-known trapezoid of pressure, the area of which represents the total load on the foundation. Ascertain the number of piles required, by dividing the total load by the safe load per pile. The piles must be distributed throughout the foundation in such positions that the axis of each pile will pass through the center of gravity of a small trapezoid whose area equals the safe load per pile (Fig. 2).

The problem now consists in dividing the trapezoid

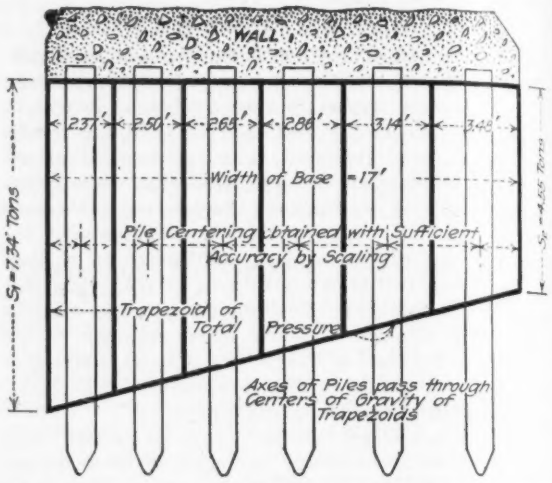


FIG. 2. METHOD OF FINDING DISTRIBUTION OF PILES

of pressure into a given number of vertical trapezoidal strips equivalent in area.

Let

A = Area of trapezoid of total pressure to be subdivided;

A_1 = Area of all equivalent vertical strips included in any width x;

x = Width of one or more equivalent vertical strips measured from heel;

$$\tan \theta = \frac{S_1 - S_2}{d}$$

$$\frac{A_1}{A} = k, \text{ a fraction.}$$

After writing out expressions for A_1 and A and placing them in the last equation above there can be found:

$$x = \frac{\sqrt{4S_2^2 + k[4d(S_1 + S_2)\tan\theta]} - 2S_2}{2\tan\theta}$$

That this formula is not so formidable as it looks will be seen in the example worked out below. The procedure is: Find x for the strip nearest the heel; then find x for the two strips nearest the heel; subtract the first result from the latter to obtain the width of the second strip, and so on until the widths of all are obtained. The centers of gravity of the various trapezoidal strips so found determine the locations of the piles.

To illustrate the operations, a pile foundation will be designed for the following conditions (Fig. 2): Base width, 17 ft.; unit pressure at toe, 7.34 tons and that at heel, 4.55 tons; total pressure on foundation per pile bent, 101.11 tons; safe load per pile 17 tons, hence six piles are required; tan θ is 0.164. The formula for these conditions becomes

$$x = \frac{\sqrt{82.80 + 132.69k} - 9.10}{0.328}$$

Solving this equation for the various widths of the

six equivalent vertical strips, 16.85 tons each in area, the figures in the following table result:

Strip Numbered from Heel	h	x Measured From Heel Feet	Width Excess of Corresponding Value of x over Preceding Feet	Area of Strip For Check Tons
	½	3.48	3.48	16.82
1	1	6.62	3.14	16.89
2	1	9.48	2.86	16.79
3	1	12.13	2.65	16.75
4	1	14.63	2.50	16.86
5	1	17.00	2.37	16.94
6	½			
Total for check				101.05

Is Beam Strength the Important Item in Brick Roads?

Valuations of Theory Must be Weighed by Experience and Practical Application—Practice Shows Beam Strength Not Essential

By Will P. Blair

Vice-President of the National Paving-Brick Manufacturers' Association

CONSTRUCTION of all roads of whatever type, in such manner, method or design as will afford the greatest economy in use and conserve most completely the expenditure therefor, is or should be a most vital concern to the people of the country at this time. Neither theoretical enthusiasm nor the energy of commercial interest should be allowed undue influence in selection, and all the evidence available should be considered when a road design is to be made. Satisfactory highway surfacings of brick, with little beam strength, have been built throughout the country, and this experience should not be ignored.

Laboratory effort is to be commended and weight must be given to the data secured. Without the aid of such data, progress by experiment would indeed have a long road to travel. The producer and manufacturer, in efforts to obtain quality, cannot afford to place his sole reliance on the unit of his production. He must understand something of its behavior in practical use, so as to conform quality to practicability. Neither can laboratory conclusions be solely relied upon. What seems to sustain an assurance must stand the test of experience and reason before complete confidence can be placed.

Laboratory and Field Conditions Not the Same

It is well recognized that no laboratory data are attainable which embrace all the influences which surround materials in practical use. In the field of experience, covering the behavior of brick roads, we can find that which will greatly assist in conserving expenditures and attaining economy in the use of vitrified brick for highways. Vitrified-brick pavement possesses an inherent unit value of superior resistance to abrasion, but no hard and fast rule is justifiable for specifications for such pavement. Brick lend themselves to the variable road-building conditions. If held in place in the pavement, their superior value as to wearing surface may be realized. It is only necessary to place the brick so that they will perform their function economically.

Extreme conditions, such as plastic soils, those impossible of drainage, hillside, hazard of overflow, etc., impose necessarily expensive treatment. But elimination of expense, without lowering the value of the pavement in any degree, is made quite possible in the case of conditions which prevail throughout a vast proportion of the highway mileage awaiting improvement.

Conditions in some localities require very expensive foundations for buildings, but it would not be good engineering to put expensive foundations under all buildings over an entire state. Throughout the greatest portion of the country they are not needed. It is only by the recognition of this principle that the taxpayers' money can be conserved and the country's ability to improve the roads now demanded can be made possible. In the use of brick a parity of relationship in the cost of construction to the traffic to be borne is likewise possible. In other words, brick are adaptable for light-, medium- or heavy-traffic roads, and the cost for each may be regulated accordingly. In each case the greatest economy is attained by including no more than is necessary for the type.

It is contended by some that slab or beam strength is an all-important factor in the worth of a brick road. They regard it so highly that they attach an extraordinary value to the fraction of the balance that measures the difference between one character of construction and another. For this reason they discriminate in their specifications in favor of the slight advantage (if any) for slab strength, in total disregard of an excessive cost. It is an unreasonable position to take—to pay so much for so little in value. If such a position is to direct the vast expenditure in road building, one can readily see a great sacrifice of money in the coming years.

Effect of Varied Conditions on the Slab

But, after all, does the rigid slab for which contention is made supply the function most wanted and, in the end, conserve economy? Bearing in mind that our laboratory data on beam strength only consist of the measured results of dead weight applied to the slab, in practice, we have dead weight, impact, abrasion, intermittent temperatures, water, frost, and all the strains which follow these influences. We have but little, indeed, of laboratory data upon these various elements of road behavior. We must rely, therefore, for study and conclusion on the great field of experience and observation now available, through the long use of vitrified brick for paving, and on the study of the varied methods of installation as well as the variable climatic and other influences to which they have been subjected.

What, therefore, is the behavior of the slab under these influences?

In the north, frost expands wet subgrades, and, regardless of the quality or thickness of the slab—be it from 1 to 12 in. in thickness—it breaks. Every careful observer of road behavior knows this to be a fact, and that it occurs with great frequency. A wide extent of visible cracks further establishes the insufficiency of any slab strength hitherto employed. They know, too, that the chief remedy against injury is not increased thickness, but a dry subgrade condition or absence of frost action.

Of expansion due to high temperature we know but little, nor do we know the exact relation of moisture and heat in their influence in setting up internal strains in concrete. We do know that it results in injury, regardless of the thickness or the richness of the mix. Numerous instances are in evidence where the beam or slab of a brick pavement but 4 in. thick, entirely unsupported by contact with foundation of any sort, has

successfully withstood heavy traffic for a period of from 10 to 20 years.

The condition affording this observation arises from an expanded condition of the slab when its joints are filled with cement. Where rupture has occurred, it has been due to pressure from below and not from weight above. But it is not sound practice to rely on this strength alone. The tension may reach its limit, and rupture may follow. Undue importance in road construction cannot, therefore, he given to slab strength. There are other factors bearing relationship to these injurious causes which will lessen or obviate them. A better appreciation of the value of slab strength can be comprehended by a view of pavement behavior where least provision is made for that element.

Examples of Satisfactory Brick Pavements of Low Slab Strength

A brick pavement leading eastward from Mattoon, Ill., rests upon one course of common brick laid flat. The joints are sand-filled. A wooden curb was originally installed but disappeared long ago. The pavement retains its grade and, with the exception of a washout at one place, it has not needed repair. It was constructed in 1899.

The first five brick streets in the City of Anderson, Ind., built in 1893 and 1894, were founded on rolled gravel bases, and the joints were sand-filled. They have not been subject to repair from wear and tear, and only cuts and openings have caused depressions. Many streets constructed in like manner in South Bend, Ind., maintain their grade almost perfectly.

Seventy per cent. of the brick streets in Cleveland, Ohio, rest upon a natural earth foundation, and, whether they are sand, cement or bituminous-filled, the grade is maintained 80% as originally placed. On many streets where natural or artificial drainage obtains the surface is intact.

Years ago brick cross-walks were constructed in many cities and towns throughout the Middle West, biding the time when the streets might be better improved. Such walks were laid upon whatever soil existed. Where not displaced for further improvement, they remain undisturbed by the travel which has passed over them. Similar construction upon extremes of resilient subgrade may be found in many cities throughout Illinois, Indiana and Ohio. Brick roads built in this manner have given extraordinary service—life, cost of construction and maintenance all considered. Where injury and destruction have occurred in such pavements they are traceable to some inexcusable neglect in construction, such as in drainage, application of the filler or compacting of the base, but scarcely ever, if at all, to the traffic.

Rolled Stone and Slag Bases

Between the extremes of practically no foundation at all and a rigid one such as is sought in the use of concrete, 5 to 8 in. in depth, there is found a most convincing attainment of economy in brick-road construction. This method is by the use of a rolled broken stone or slag base. Approximately 65 miles of the National Road, extending westward from Wheeling, W. Va., to Zanesville, Ohio, are brick-paved. Sections of this road are built upon a rolled base of crushed brick-bats. Other sections are built upon a rolled slag base, and the remaining sections are built upon a base of rolled sandstone.

The road was carefully inspected recently by a number of engineers, in company with the writer. Not more than a half-dozen depressions below the grade were discovered in its entire length, and these were but slight indeed. Much of this mileage has been in use for more than five years. Both cement and bituminous fillers were used.

South Sixth St., Terre Haute, Ind., is built upon a broken stone base and has been in use for 27 years, without a single depression.

Around the court-house square at Lebanon, Ind., and on the street leading thence to the railroad depots, similar brick pavements constructed more than 20 years ago are without a single repair; and present a splendid surface and grade.

The brick-paved roads in Mahoning County, Ohio, of which there are more than 100 miles and which were constructed under the supervision of Ett Smith, engineer, furnish most valuable examples of the worth of brick laid upon old macadam, rolled stone or slag bases. A careful inspection of these roads clearly demonstrates the economy of this kind of construction. One of them, known as Inter-County Highway No. 82, is 10 years old. The base consists of rolled slag. The joints of the brick are sand-filled. Over this road passed all the heavy Army trucking from the Northwest. It has not been subject to any repair whatever. The rolled-stone base in connection with the use of the bituminous fillers such as have been developed and used for the past five years in the West, which possess extraordinary adhesive qualities, do not flow in warm weather or become brittle in cold weather, insures an economic durability which can scarcely be surpassed.

Proper design and care in construction are equally important, but more failures are due to neglect in construction than to other causes. Not less attention in other directions, but greater efficiency in supervising construction, is a crying need. Conditions surrounding road building are many and variable; economy and service must be the goal. No single cure-all, however plausible, can be applied. Adequate ingenuity, skill and sound judgment are required for the best attainment.

Cost of Railway Ditching

Different methods of cleaning railway ditches and the costs of these methods at 1918 prices are given in a committee report presented at the recent annual meeting of the Roadmasters' and Maintenance-of-Way Association in Chicago. The figures are for work on single track with six trains during working hours, the roadbed being in soft clay and the ditches being 3 ft. wide, 2 ft. deep and 7 ft. from the rails.

	Cubic Yards per Day	Cents per Cubic Yard
1. Ditcher of steam-shovel type, on cars; ditch labor, $18.90; work-train labor, $28.36; rental of equipment, $31; maintenance, $1.45; supplies, $12.80; total $92.51	224	41.30
2. Steam ditcher of drag-scraper type; ditch labor, $31.75; work-train labor, $28.36; rental, $30; maintenance, $0.93; supplies, $10.62; total, $101.66	252	40.34
3. Push cars (2): 1 foreman at $83, $2.77; 11 laborers at $2.25, $19.80, total $22.57	38½	58.62
4. Car barrows: 1 foreman, $2.77; 4 laborers, $7.20; total $9.97	13	76.70
5. Wheelbarrows: 1 foreman, $2.77; 6 laborers, $10.80; total $13.57	19	71.42
6. Casting or shoveling: 1 foreman, $2.77; 6 laborers, $10.80; total, $13.57	38½	35.25

Methods Used by Germany in Overcoming Tire Shortage

Steel Bands Cushioned by Wood, Rubber and Steel Springs Utilized—Asphalt Composition and Jelly-Filled Shoes

By H. M. Kistler
Captain, Infantry, United States Army

MANY expedients were employed by the German Army during the war to overcome the rubber-tire shortage. Among them were bands of steel cushioned by wood, rubber and steel springs, and asphalt-composition tire. Utilization of old tire shoes by pumping them full of a substance similar to jelly was also tried. As early as 1916, Germany found herself in need of rubber for auto tires. She had no reserve and was cut off from all sources of supply. She issued an order that all individuals and organizations possessed of bicycles, automobiles, or trucks should immediately present the tires to the Government for purchase, unless they could prove to the satisfaction of the officials that the surrender of the tires and the storing of the machines would seriously cripple their businesses. The interpretation of this order was strict, and pleasure cars became luxuries unknown. While this order helped the situation, yet Germany was compelled to use her ingenuity to supply the tires she required.

The accompanying illustrations show a few of the substitutions which may be seen in Berlin and throughout Germany today. In a way they served their purpose; the chauffeurs have not been arrested for noisy driving; and when a machine was completely knocked to pieces, it was junked. Germany's automobiles were and are still expensive necessities.

Practically plain steel tires were used on some of the trucks. A steel band 1½ x 4 in. is held on the wheel by means of wooden boards curved under steam and pressure. The wood is designed to absorb a little of the vibration; perhaps it does. The machine, however, gets its full share, and anyone who happens to be near has the full benefit, also.

In Fig. 1 are shown two other types. The front wheels are equipped with spring tires. The ends of the

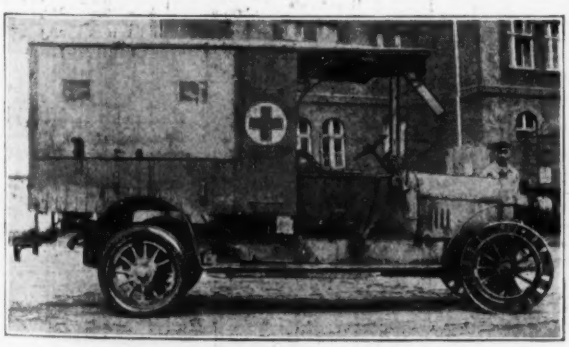


FIG. 1. STEEL SPRING TIRES IN FRONT AND JELLY-FILLED SHOES AT REAR

springs are fastened to the rim, and are immediately surrounded by a ¼ x 3-in. steel band into which they are fitted. This band holds them in place while a similar band is added for strength. This substitute is heavy and noisy, but travels with surprisingly little vibration. On the rear wheels are old shoes which have been overhauled and faced with steel rivet studded leather. After the shoes are mounted on the rims they are pumped full of a substance the drivers call "marmalade" or jelly. No tubes are used. This travels much like a solid tire. Its chief fault lies in the fact that, after being driven several hours, the marmalade becomes hot and runs out over the rim. The tire must then be replaced until it can be refilled in the workshop.

The front tires shown in Fig. 2 are similar to those in Fig. 1, except that solid-rubber blocks are used in

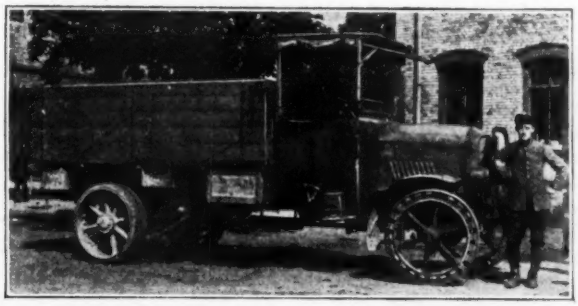


FIG. 2. RUBBER SPRING TIRES IN FRONT AND ASPHALT COMPOSITION ON REAR WHEELS

place of the springs. The rubber blocks are fitted into and held in place by cast-iron cups secured to the rim and band. The tires on the rear wheels have all the appearance of solid rubber, but are of asphalt. They perform their mission well, and make a fair substitution for solid rubber.

Fig. 3 shows a bicycle equipped with a type of tire which is seen less frequently as rubber is beginning to arrive. Toward the close of the war the Army issued such bicycles to its troops. It runs noisily but fairly

FIG. 3. BICYCLE WITH OPEN SPRING TIRES

lightly on sandy roads or paved streets, but is practically useless in clayey country.

Other types are to be seen throughout the country, but they follow the same principles. None functions as rubber. Suffice it to say that, if there is a real substitute for rubber in tires, Germany lacked either the men or the means to produce it in her hour of greatest need.

French Airship Sheds Built of Framed Concrete

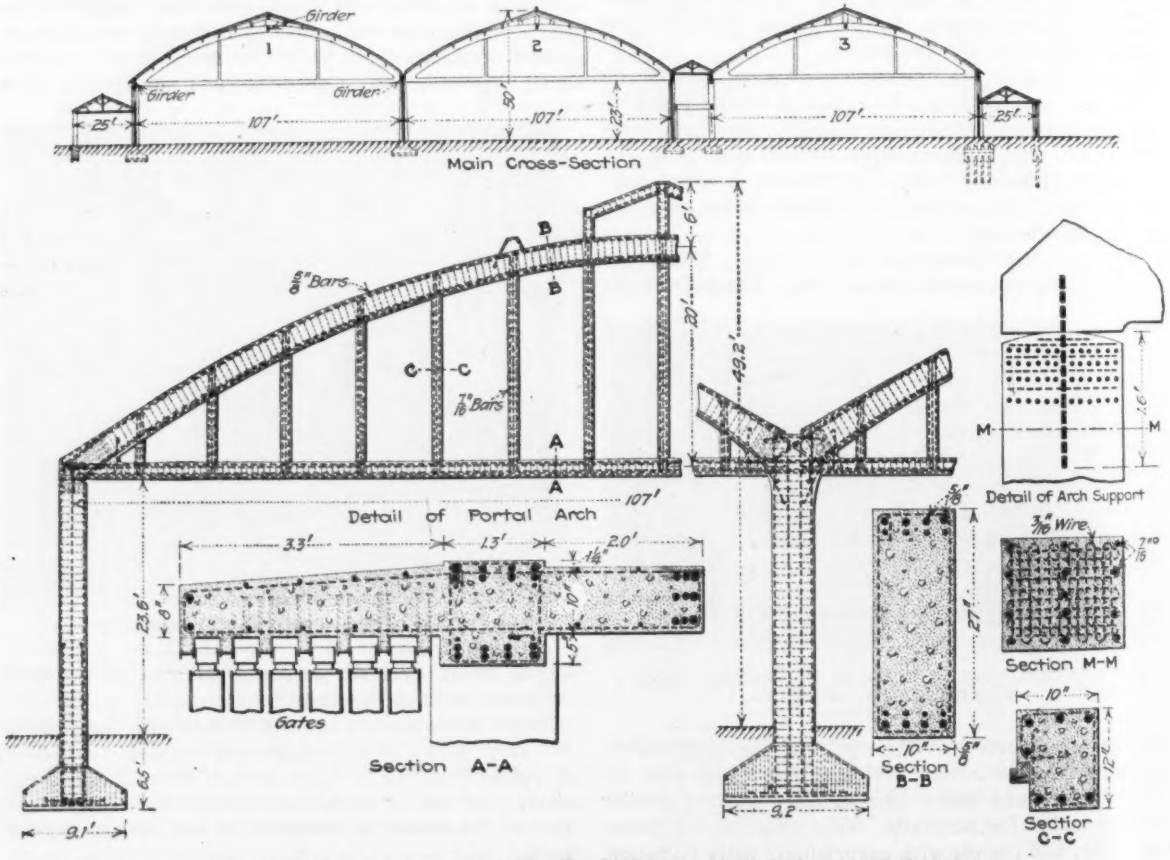
Both Arch Truss and Three-Hinged Arch Ribs Used as Roof Which Is Supported on Light Framed Side Posts

LARGE sheds to house airships are coming into general use. They constitute a somewhat new demand on the art of structural engineering, for while they resemble in their general outlines the familiar armory roof, they require somewhat less architectural quality, and there is every prospect of their running to much greater sizes than have hitherto been used in armories. The large dirigibles projected by the various governments approach 1000 ft. in length, and as economy suggests a roof to hold two such balloons, the width must be well over 300 ft. Difficulties of landing and launching, apparently, also require the height be around 200 ft. The French Navy, for instance, has already adopted a design for a shed 723 ft. long, 360 ft. wide, and 174 ft. high, while the United States Navy has under construction at Lakehurst, N. J., a shed of similar gigantic proportions.

In France, during the war, some of these sheds were built of reinforced concrete because of the shortage in steel. In fact, the large shed noted in the preceding paragraph is of reinforced-concrete design. There was built a shed of similar outline but smaller dimensions at Montebourg, in France, which was only designed to hold one dirigible. This shed, the design of which is described herewith, is 493 ft. long, has an open width of 80 ft. and a height to the under side of the roof of 100 ft. It consists of three-hinged arch ribs supported at a height of 61 ft. from the ground on triangular vertical bents. Another reinforced-concrete shed was built for planes by the French Government in Algiers during the war. This was in three bays each 107 ft. wide, with a clear height of 23 ft., and with a roof consisting of a tied or restrained arch resting freely on the columns.

The Montebourg shed, designed by the French engineer Henry Lossier, has the main framework—that is, the triangular vertical bents and the arch ribs—of concrete poured in forms in place, while the roof consists of reinforced-concrete precast purlins carrying reinforced-concrete precast tile. The arch ribs are spaced 20.5 ft. c. to c. Each rib is to the theoretical equilibrium curve so that the pressure keeps within the middle third under all conditions of load and wind pressure. The rib section is 30 x 13 in., and is reinforced with twelve $\frac{7}{16}$-in. rods with $\frac{1}{4}$-in. stirrups, as shown. Six of the main rods continue for the whole length of the semi-arch ribs, the other six are turned with the curved ends at various points along the rib, as shown in the drawing. The supporting bents are triangular trusses of the general dimensions shown in the drawing and rest on heavy concrete blocks set into the ground.

Crown and spring joints are of the type familiar to students of French concrete design as the Mesnager system. They consist of reduced sections of the continuous concrete shaft of the rib heavily reinforced in the section itself and with heavy rods crossing at

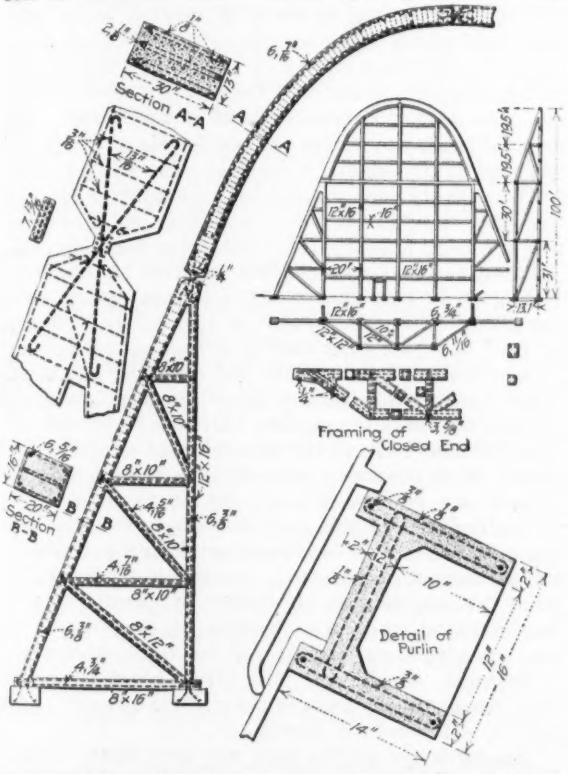


REINFORCED-CONCRETE SHEDS FOR FRENCH HYDROPLANES AT ALGIERS

the middle of the joint and extending up into the main shafts.

The purlins are of the channel section shown in the drawing and are precast concrete, reinforced with light rods, and of length sufficient to span the 24.5-ft. spacing of the ribs and bents. They have the reinforcement continued out beyond the concrete, and are placed in the forms of the frames during construction, the concrete being poured around them to complete the joints. Each channel purlin is braced at the third point with a cross-rib. Projecting lugs stick out towards the roof to engage lugs in the tile, as shown in the details.

The shed is divided into three parts of its length for expansion purposes. At these joints there are two sets of bents and ribs with an opening of 2 cm. and



REINFORCED-CONCRETE SHED FOR FRENCH DIRIGIBLES AT MONTEBOURG, FRANCE

an overlap of the roof tile. The entrance end of the shed is open and provided with a movable door, and the other end is closed by a wall—whether of concrete, tile or brick cannot be determined from the information at hand. At any rate, the main detail of the inclosure is a trussed vertical frame which holds the wall covering, and which is stable in itself to resist any wind pressure against the end of the shed, so that such pressure will not be transmitted into the main frames but will be taken up in the reaction of the trussed frame on its foundation. The movable steel gate or door is in two sections, one for each half of the shed. It is a self-supporting triangular vertical truss framing and moves independent of the shed itself on a solid-base platform on the ground, with wheel bases at the foot of the truss 43 ft. apart.

The Algiers sheds aer built for hydroplanes and therefore do not require as great height as the balloon sheds. The sheds numbered 1 and 2 on the drawing were first built, No. 3 being added after the others were completed. Each shed is 107 ft. wide and 132 ft. long, with a clear height to the bottom of the arch tie of 23.6 ft. Alongside are two subsidiary sheds 25 ft. wide with small truss roofs. The main part of these sheds are tied arches of reinforced concrete spaced 16 ft. c. to c. resting on reinforced-concrete columns with interposed spherical bearings, shown in the drawing, at the outside posts and with rigid connections at the inner posts. Longitudinal bracing is provided by stringers at the top of the posts and at the crown of the arch. For the portal arches the tie-beam is supported from 15 hangers placed at $\frac{2}{7}$ of the span from the end. As in the case of the larger shed, the purlins are of concrete, but the roof itself of wood, with frequent glass openings. The rear end of the shed is closed with a brick wall, but the front is open and has a rolling door supported as shown in the drawing on an extension of the end tie-rod of the arch. This shed was built under the direction of the Ponts et Chaussees. Both sheds are described in recent issues of *Le Génie Civil.*

Burnt-Clay Aggregate and Wood Reinforced Concrete

Scarcity of the usual materials for making reinforced concrete on some outlying work in British Guiana led L. P. Hodge, an engineer in that country, to investigate the possibility of burnt-clay aggregate instead of stone, and of wood instead of steel for reinforcement. The results of his studies are noted in London *Engineering* of Sept. 5, 1919. Unfortunately, they are not given in enough detail so that anything very definite can be deduced from them, except that wood-reinforced concrete with burnt-clay aggregate was successfully used in some bridge structures, even in some precast piles.

The clay used is what the author calls ordinary coast alluvium with the following analysis: Silica crystallized, 19.6%; silica combined, 34.7%; alluvium, 11.9%. This was burnt to clinker, and screened through a 1-in. mesh and retained on a ¼-in. mesh. It was used in a 1:2:4 concrete, with a British standard portland cement. The author assumes that the seven-day ultimate strength would be 1400 lb., and designed the concrete for 300 lb. per square inch. The wood used in reinforcement was of a local greenheart, with an ultimate tensile strength of 8800 lb. per square inch. It was used as reinforcement in pieces of about 1 x 2 in., and apparently was satisfactory in the tests. Seventy-two piles, 12 in. square, 25 ft. long, reinforced with two 2 x 2-in. corner wood rods, and two 2 x 3-in. corner wood rods, were driven in the bridge abutment through about 17 ft. of clay, about one month after casting. None failed or had to be recast. The piles were driven in the front and wing wall of an abutment, and the earth was retained against slabs of steel-reinforced burnt-clay aggregate concrete backing against the piles.

The author concludes that wood and clay in such use are satisfactory if no other materials can be obtained. The wood should be soaked at least 24 hours before being put into the concrete; otherwise it will tend to set up cracks.

Good Roads Without Great Debt In Bond Issues

New Iowa Law Provides Pay-As-You-Go Plan for 6278-Mile System of State Roads—Motor Vehicle Fees To Be Utilized

THOUGH today the mileage of paved roads in Iowa is negligible, the state plans to have within a decade, as the result of its preparation for quantity production, a hard-surfaced road system of over 6000 miles. This mileage will also have been built from current funds. The distribution of the improvement will be uniform. Each of the 99 counties will have a mileage in exact proportion to its area, and, counting both urban and rural population, fully 95% of the people will be able to reach a paved road by a journey not exceeding 1½ miles.

An act which became effective Apr. 19, 1919, establishes a system of primary and secondary roads and provides means for paving and otherwise improving both. The primary-road system has been located by the county engineers and revised by the engineers of the highway commission. It aggregates 6278 miles and connects every town and market place of 1000 inhabitants or more. The secondary system is composed of all the remaining roads—about 98,000 miles, in round figures.

The new law, in effect, substitutes primary roads and secondary roads for the old classification of county roads (16,000 miles) and township roads (88,000 miles). The 6278 miles of primary roads are the old county roads. The remaining 10,000 miles of old county roads are relegated to the secondary system. There are, then, primary roads, county secondary roads and township secondary roads. Administration of county and township road work is unchanged.

Initiation of Road Work Lies With Community

Initiation of primary road work lies with the community. No county may proceed with any paving project on any part of the primary system until the county at popular election shall sanction the general policy of hard-surfacing its roads. Once the people have voted for hard roads, the county road supervisors proceed on such program as they determine. Provision for paving secondary roads is made by authorizing the establishment of an improvement district by the county supervisors upon petition of 20% of the land owners.

The fund for paving primary roads comes (1) from Federal-aid allotments; (2) from motor-vehicle license fees, and (3) from special assessments against benefited property. The Federal-aid and automobile license funds are apportioned to the 99 counties according to area. Each county, however, does not receive its share annually. Instead, based on computations of the amount of Federal money coming to the state for the period covered by the Federal-aid allotments, and an estimate of the probable motor-vehicle license fees for the same period, the total due each county from both sources is estimated. Taking turns, the counties receive their full allotments in lump sums, and pave their primary roads all as one project. To their allotted funds the counties add as the work progresses the special assessment of 25% of the cost against benefited property. If a county does not care to postpone paving until its turn comes to receive its allotment of primary road money, it can issue 15-year, 5% bonds to the estimated amount, and use its allotment, when received, to retire these bonds.

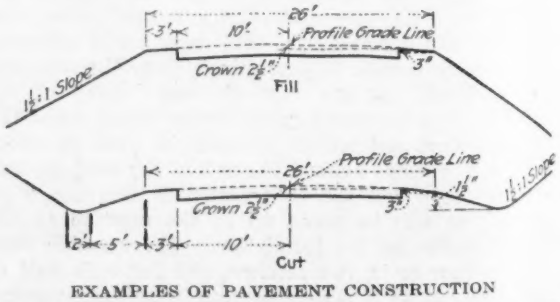
For paving portions of the secondary road system, the county supervisors, at discretion, upon petition of 20% of the land owners, create paving districts. If the district is on a county road, the county road cash fund pays 75% and the property benefited pays 25%; if it is on a township road the county pays 25%, the township 50% and the property 25%. Townships are helped in the matter of road funds for this and other township road purposes by a two-mill extra levy on all property, both rural and city.

Estimates indicate that the funds from motor-vehicle licenses and from Federal aid for paving primary road will in 1920 amount to about $8,000,000, and a large sum will accrue each succeeding year. These sums spent in permanent paving do not curtail the amounts which have been available in the past for normal county and township construction and maintenance. The original funds are hardly touched for the primary road work, while the original mileage is reduced to the extent of the primary road mileage, and, in addition, there is the extra two-mill tax for construction and a new one-mill tax on all property for maintaining township roads.

Paved road construction begins with an asset consisting of the permanent construction performed under the law of 1913. At the end of 1918 about 2900 miles of road had been completed to permanent grade—that is, to standard line, gradient and curvature and to full width and cross-section, with all drainage work and bridges and culverts complete. Of this 2900 miles perhaps 2000 miles are on the primary road system of 6300 miles. With the crown scraped down and the subgrade shaped, this mileage is ready for the paving gang.

Another considerable portion of the primary mileage has been brought to temporary grade and has many of its permanent bridges and structures completed. Besides this preparation physically for quantity production of paved roads, a comprehensive organization has been completed and trained for the technical direction of the work. On Aug. 1, 1919, fifteen counties had held elections on resolutions to pave their primary roads and 13 had voted for paving.

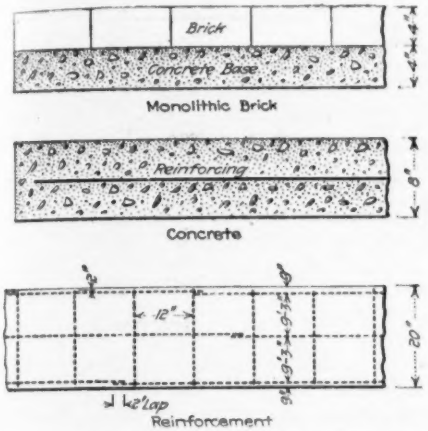
Standards for paving have not been finally adopted in detail. The diagrams herewith show typical sections in cut and in fill of paved roads, and these sections will



EXAMPLES OF PAVEMENT CONSTRUCTION

doubtless be closely followed. Widths of paving will extend upwards from 16 ft. Examples of brick and concrete pavement designed for a specific project are illustrated. The striking feature is the reinforcement of the concrete design at the center of the slab. This

reinforcement consists of ½-in. square bars, and is introduced chiefly to prevent cracking. Practice in respect to concree materials, proPortions, consistency,



TYPICAL SECTIONS OF PRIMARY PAVED ROADS

and methods of placing and finishing conform to general practice. Dry concrete has not been adopted.

Control of New Streets in Relation to Extension of Water Mains

By Bertram Brewer
Assistant Engineer, State Department of Health, Boston, Mass.

THE interesting discussion at the March meeting of the New England Water Works Association this year on the subject of financing the extensions of water mains, especially with reference to the possibility of special assessments on the abutters, suggested to the writer another problem connected with this particular branch of water-works activities. Neither the possession of the money nor satisfactory means for procuring it necessarily secures a proper street to build in. Both suitable conditions and a suitable location may be lacking. Very likely the street lines are not so marked on the ground as to make it possible to locate properly the new pipe line and the new surface fixtures.

While it is often very difficult to determine whether the public's money ought to be spent in laying water mains in these doubtful street developments, the question has a larger aspect in that it has to do with the orderly and reasonable development of the whole municipality—the town or city plan. It seems to the writer that the official in charge of the water department can exercise an exceedingly important influence in acutally making operative the town or city plan, because it is usually he who, by placing water pipe in a new street, first gives public sanction to its layout.

The initial control of new street development, so far as such control has been exercised, has, in Massachusetts, been delegated to an official body called the Board of Survey, a name that was adopted by the City of Boston in a law passed by the General Court in 1891 (Chap. 323) when a Board of Survey was established for that city under the able leadership of Ex-Mayor Nathan Matthews.

Briefly stated, the Boston law provided that either through the initiative of the Board of Survey or by petition of those developing land, all prospective streets must receive official sanction. Following is a condensed statement of some of the permanent interests of the whole community which are covered by this and later Board of Survey laws: [Now adoptable on option by any city or town in the state.—Editor]:

1. A plan, sufficiently accurate and complete so that the exact boundaries of the street can be easily reproduced at any time, must be permanently filed with the public records.

2. This official plan must show a final and reasonable street grade, also capable of reproduction at any time.

3. Due attention must be given to good connections with existing highways, as well as to an intelligent provision for future thoroughfares, all to be secured at a minimum of cost consistent with the conservation of the natural advantages of the entire district for home sites, factory sites, public uses or otherwise, as the case may be.

4. The development must be such as will provide a good system of sewerage and drainage for the district to be laid out, as well as suitable connections with the systems in the contiguous territory.

5. The new layout must accord with a reasonable development of the water-works system with due regard to cost, accessibility and circulation.

Sec. 9 of the Boston law of 1891 attempted to prevent building within the boundaries of a street approved by the Board of Survey, or at a grade other than one that would accord with the grade shown on the official plans. The courts declared this unconstitutional in that it took away certain individual rights without adequate compensation.

An act passed in 1918 (Chap. 110), applicable to towns only, appears to give to the proper authorities the right to establish formally the lines of Board of Survey streets without compelling their immediate construction. It prohibits new building within the lines of such streets, and provides for the payment of damages. It seems to the writer that its provisions and application are somewhat indefinite and might involve a town in two damage payments, one when the Board of Survey street lines were established by the town and another when the time came for constructing the street.

The author would suggest that while it is a fact that thus far the Government of this country has been wisely built upon the rights of each individual to hold and transmit private property, it would seem that the roads are in a peculiar class. It is certain that just as soon as a street is laid out on paper and lots are sold abutting upon it, certain public works, especially the water-supply, are demanded and the street is started on a course which insures its becoming in time practically the property of the public. Is it not, then, perfectly reasonable for that public to have some choice as to what kind of property is to come into its possession? It would seem that this peculiarity, ultimate and certain public ownership, puts the new street in a class by itself when it comes to public control over its alignment and grade.

The author believes that a scheme of control is in the process of making, a control that will ultimately eliminate the uncertainties that confront the water-works officials when they undertake to extend water-works pipe lines into private and unaccepted streets. Can your help be enlisted?

Electric Hoists Pull 3000-Ton Building 450 Feet

Ingenious Arrangement of Pulling Cables Enables Three Hoists to Apply Even Pull on Concrete Building at Twelve Points

BY A special arrangement of pulling lines, three 90-hp. electric hoists moved a three-story reinforced-concrete and brick building at the rate of 50 ft. a day, in clearing the site for the new $10,000,000 building of the General Motor Corporation in Detroit, Mich. The total distance traveled was 450 ft. from the old foundations across a street to new foundations prepared in advance. The building measured 60 x 95 ft. and weighed 3000 tons. In preparation, the four walls and 12 interior columns had to be cut clear of the footings and then the whole structure had to be raised 3 ft. vertically. The moving was performed while the building was occupied for its regular uses, and without interrupting telephone, light or power service.

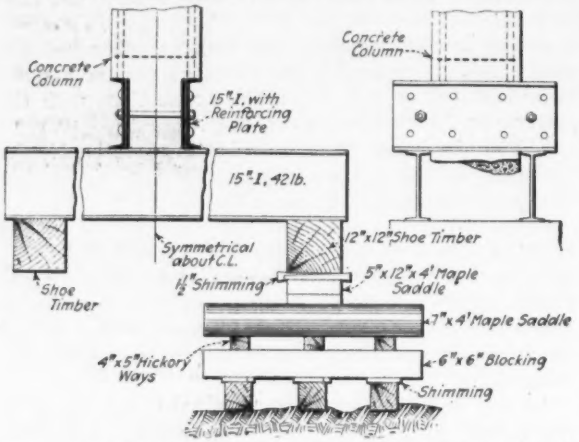


FIG. 1. INTERIOR COLUMN SUPPORT ON MOVING RUNS

Technically the operation presents two features: (1) Mounting the several supporting elements of the structure stably on the moving platform, and (2) applying the pull, by means of wire cables, of three power units, evenly and uniformly along the 95-ft. dimension of the moving platform.

About one-third of the weight of the building was carried by 12 interior concrete columns from 20 in. to 22½ in. in diameter. Each column was cut free and mounted as shown by Fig. 1. The channel clamp, I-beams and shoe timbers were placed and jacks were put under the shoe timbers. At the same time the walls were underpinned with needles, I-beams and shoe timbers, as shown by the view, Fig. 2, and jacks put under the shoe timbers. Altogether, 500 jacks were installed. Then the walls and columns were cut free from the footings, and the whole building was raised by simultaneous operation of the jacks, blocking being built up as the raising progressed. The saddles, rollers and ways were finally placed, and the building was mounted ready for moving. No interior bracing was employed, except under the long span of the garage entrance at the rear of the building.

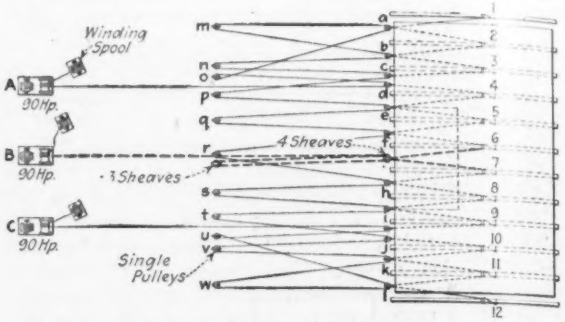


FIG. 3. ARRANGEMENT OF HITCHES AND PULLING CABLES

Twelve runs of shoe timbers, saddles, rollers and ways were employed, each carried by a track of blocking. For the first move the runs were completed about 60 ft. ahead; thereafter they were built ahead gradually as the travel of the building released the timbers at the rear. A level foundation was excavated for the blocking. Timber exclusively was employed in constructing the runs, it being considered that it combined elasticity and rigidity in a manner which minimized moving stresses on the building structure.

The travel of the building was in the direction of the shorter dimensions, and the problem was to distribute the pull evenly along the 95-ft. dimension, using three 90-hp. hoists for power. Fig. 3 indicates the arrangement adopted. Hitches 1 to 12 were made with 1¼-in. cable to the shoe timbers near the longitudinal axis of the building. To the free ends of the hitches were fastened single pulleys a to l. Well ahead of the building

FIG. 2. WALL SUPPORT ON MOVING RUNS

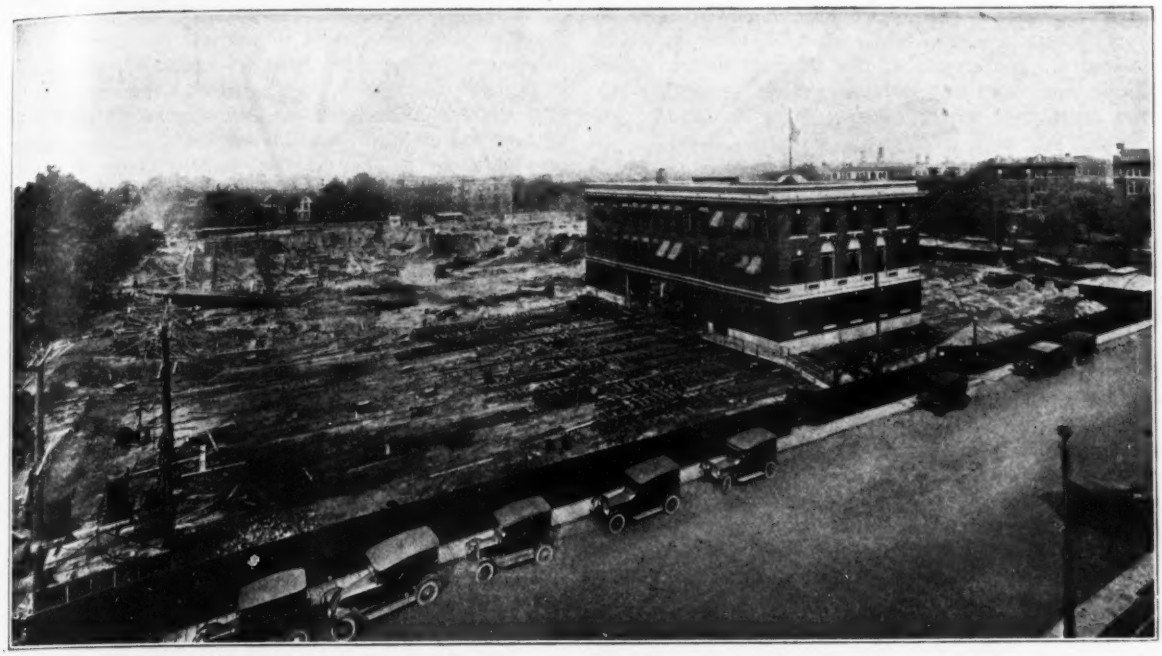


FIG. 4. MOVING A 300-TON BUILDING 450 FEET

similar pulleys n to w were anchored. From hoist, A, a ⅜-in. wire cable was rove through these 23 pulleys and thence to hoist, B, as indicated by the diagram, Fig. 3. This arrangement insured an even pull on each hitch whether or not the drum speeds of the two hoists, A and B, were exactly uniform. A separate hitch and pulling line arrangement, as indicated by a distinctive symbol on the diagram, were employed for the third hoist, C.

The moving operation developed no cracks or other disturbances of the building structure and, as stated, the owner, the Hyatt Roller Bearing Co., occupied it for regular business during the whole period of raising and moving. The contractor for the operation was the L. P. Friestedt Co., Chicago, Ill.

Reinforced-Concrete Pipe Made By the Centrifugal Process

Cylindrical Form Is Placed Around Wire-Covered Mandrel, Concrete Is Poured and Whole Rig Spun Until Concrets Sets

By E. M. Weston
Union Club, Johannesburg, South Africa

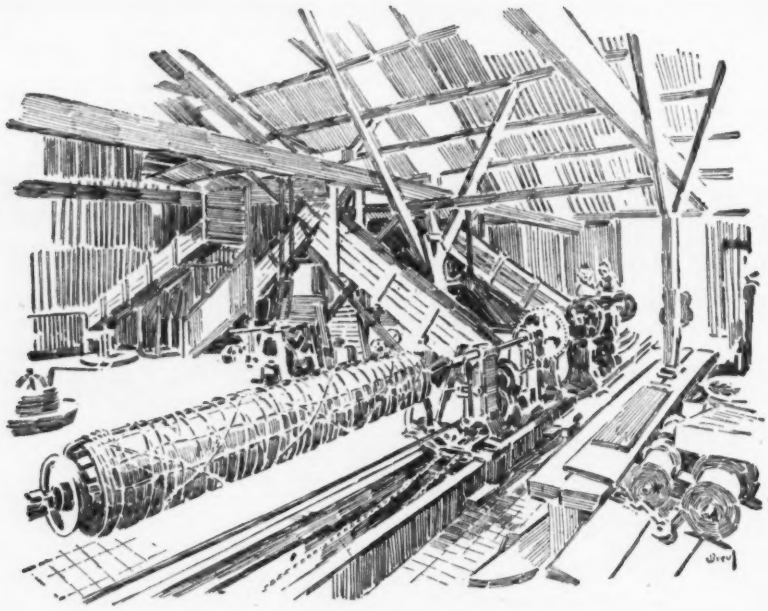
CONCRETE pipe which have been tested without serious rupture for an interior water pressure up to 400 lb. per square inch are being made by the centrifugal process for a number of uses in Australia and South Africa. The method of manufacture was developed by W. R. Hume, of Adelaide, South Australia, and the pipe are being made under concessions from him. In brief, the system consists of whirling a pipe mold full of concrete on a horizontal mandrel, trusting to the centrifugal action to compact the concrete.

The pipe are being made in 4-, 6- or 8-ft. lengths. The reinforcement is of wire. In South Africa old steel winding ropes from the mines are heated, to anneal and soften the wires and to burn off grease. They are then wound in various ways upon revolving cylinders the same diameter as the inside of the pipe, a sort of ropewalk being used for unwinding the strands of old rope.

The mold consists of a flexible $\frac{1}{16}$-in. steel cylinder cut in half lengthways and re-joined by hinges and clamps, so that when it is opened the pipe can be removed. This mold is placed horizontally on the rotation friction rollers of the casting machines. When a pipe is to be made, the steel wire reinforcement is placed inside the mold. Flanges, the same depth as the required thickness of the pipe walls, are placed on the end of the mold, and wet concrete of various grades corresponding to the quality of the pipe required is introduced from the ends, which are open except for the flanges mentioned. The pipe is revolved slowly at first, and the concrete is automatically destributed evenly along the whole length of the pipe and around the circumference, and completely incases and embeds the reinforcement.

The pipe is then revolved more rapidly, and the excess water, with any impurities, is collected in the center of the pipe and drawn off at the ends. Pipe of 4-in. diameter can be "spun" out at the rate of one per minute. Pipe 6 in. in diameter take 2 min.; 18-in. diameter take 8 min., and 48-in. diameter 20 min. The concrete by this time has set so hard that it is impossible to make an impression on it with the finger. The molds are run into a steam house for 24 hours and then opened, and the pipes are seasoned in water tanks for a month, usually. Pipe can, however, be put to use within a week.

The pipe show a remarkable density, and are impervious to great pressures either in sections or as a continuous line. A joint as strong as or stronger than the main itself has been designed. The ends of the pipe are recessed and butted together, forming a diamond-shaped cavity between them. A collar 6 in. wide, of strength similar to that of the pipe, is put on and secured with a backing of cement at both ends.



REINFORCED-CONCRETE PIPE ON MANDREL IN SHOP

Between the pipe a plastic bituminous cement is inserted, and pressure tends to compress this in the annular cavity of diamond-shaped section. This makes a joint which has been tested to 400-lb. pressure. Experiments show that a pipe designed for 100-lb. pressure shows at 200 lb. faint lines of dampness; at 250 lb. this becomes a dew. At 300 lb. the dew develops into a heavy sweat, and at 350 lb. jets of the finest misty spray appear. If this pressure is reduced the pipe takes up and is as capable as before of carrying 100-lb. pressure.

Until 1916 there was considerable skepticism concerning the suitability of these pipes for high pressure. In that year J. C. Ross, city engineer of Hobart, recomended the installation of 10 miles of 18-in. pipe to pass 13,000,000 gal. of water per day under a head of 250 to 350 ft. This line was successfully laid with a saving of $15,000 over cast iron, and the pipe is now almost universally used in water-supply and irrigation projects in Australia. Cylinders 10 ft. long and 6½ ft. in diameter are being made by this process for use in harbor works at Burnie, Tasmania, and cylinders 15 ft. in diameter have been made for use as buildings and silos.

Consistency of Cores of Hydraulic-Fill Dams Tested by Three Methods

DURING the progress of the hydraulic-fill work on the five detaining dams of the Miami Conservancy District in Ohio, the consistency of the core material is checked up in several different ways, with a view to making sure that solidification goes on rapidly enough to eliminate danger of slumping or bursting. H. S. McCurdy, engineer of the Englewood dam, stated before the New England Water Works Association at Albany, Sept. 30, 1919, that the core material is becoming stiff at the lower elevations. Referring specifically to the Englewood dam, he reported that a pole of 1½-in. diameter shoved into the core meets sensible resistance at about 15 ft., and that at 25 or 30 ft. penetration a man's weight will force the pole no farther.

In regular practice, resistance to penetration is measured not only by a pole, as just mentioned, but also by a 6-in. cast-iron ball. This ball method is the same as was used at the Calaveras dam of the Spring Valley Water Co. in California, so that the results will give comparisons not only between the five dams of the district, but between these and the Calaveras dam. In addition, Goldbeck pressure-recording cells are being built into the cores of the dam, so as to enable a record of the lateral pressure exerted by the core material in its change from fluid to semi-fluid and ultimately solid condition to be measured; this is on the view that lateral pressure is related to fluidity and that solidification will mean a decrease in lateral pressure.

Military Opinions on Scales for United States Maps

Metric, Decimal and English Systems of Measures Are Compared—Several Scales Needed—Contour Intervals Vary

WHAT scales should be adopted in mapping the United States for military purposes? This subject is discussed by Lieut.-Col. R. C. Kuldell, Corps of Engineers, U. S. A., in a paper on "The Military Mapping Problem in the United States," published in the March-April number of the "Professional Memoirs of the Corps of Engineers, United States Army." The system as used by the United States Geological Survey and for the progressive military map begins with 1:1,000,000, and doubles in series to 1:500,000, 1:250,000, 1:125,000 and 1:62,500.

Colonel Kuldell thinks that while the last is the scale most often met with in maps of this country, it is unfortunate in that most people use it as 1 in. to the mile, so that distances are given only approximately. The value of the 12-in., 6-in. and 3-in. scales now used is said to depend on whether it is decided to use for military service the decimal scales for both distances

and contour intervals, or to adhere to our standard unit of measure. As to the value of the two systems, Colonel Kuldell considers the metric system superior in every respect, but he points out that under present conditions a stated number of yards or miles conveys to the mind a definite distance, while a number of meters or kilometers induces a mental calculation to convert it into yards or miles, with a feeling that the result is only approximate. In this connection he makes the following statement:

"To obtain funds to make the desired maps, we must prove that these maps are of commercial value. The popularity of the United States Geological Survey atlas sheets is well known. The public knows that these maps are well worth their cost. Were we to print our maps on the scale of 1:20,000, with contour interval of 5 m., it would be like publishing a newspaper in a foreign language, and about as popular. On the other hand, our new artillery is supplied with instruments on the metric scale, and our officers have learned to use this scale."

Suggests Double System of Scales

A system of scales for both systems is suggested by Colonel Kuldell, as shown in the accompanying table. Of these, only the 1:500,000 and 1:10,000 should be made in the field and where the latter is made the former need not be made. All other maps would be made by reduction except the 1:5000, which is made in skeleton only from the 1:10,000 field sheets and filled in as needed by additional field work. In general, therefore, the task of securing adequate and accurate maps of the United States and its possessions consists in mapping the entire area at the scale of 1:50,000, except areas of strategic importance and training areas, which should be mapped at 1:10,000.

A considerable area has been mapped by the United States Geological Survey, and maps on a scale of 1:62,500 have been published. The field work on these maps was done on a scale of 1:48,000, and it would, therefore, be possible to reproduce the sheets on the scale of 1:50,000. To change the contour interval from feet to meters would require a great deal of costly work, but it could be done. On the other hand, says Colonel Kuldell, if the English units are retained the 1:63,360 scale should by all means replace the 1:62,500 scale, which is neither metric nor English.

The 1:10,000 scale for the field work should be used rather than the 1:20,000. Areas which are to be covered by the large-scale maps are relatively small. They consist of the territory within a radius of 20 miles of all important seacoast and border cities and the interior training areas. In all cases, the 1:10,000 map will be demanded by the artillery, and in many parts of the area the smaller infantry units will demand the 1:5000 map. To produce these satisfactorily the field scale should be not less than 1:10,000.

Contour Intervals

Closely allied with the question of scale is that of contour interval. Unlike the scale, the contour interval cannot be changed by photographic enlargement or reduction. This is a serious objection to prescribing rigidly the contour interval for each scale. Another and important objection to this practice is the freedom of expression that is taken from the topographer when he is required to portray level ground and mountainous ground on the same scale with the contour interval. Colonel Kuldell cites the following rule that has been adopted by the Chief of Engineers, U. S. A.: "The contour interval will be determined by the Chief of Engineers, having in view the maximum detailed delineation of the ground forms consistent with cartographic clearness. For each area the Chief of Engineers approves the contour interval before the field work is begun."

SCALES FOR MILITARY MAPS

Purpose	English	Metric
Aeronautic maps	1:190,080 or 3 in.—1 mile	1:200,000
Staff and progressive military maps	1: 63,360 or 1 in.—1 mile	1: 50,000
General maneuver map	1: 21,120 or 3 in.—1 mile	1: 20,000
Artillery map	1: 10,560 or 6 in.—1 mile	1: 10,000
Local defense or attack map	1: 5,280 or 12 in.—1 mile	1: 5,000

That adoption of the metric system by the United States Army should only follow its adoption by the entire country, is the opinion expressed in a discussion of the above paper by Col. E. H. Marks, in charge of military survey and mapping in the office of the Chief of Engineers, U. S. A. He states that an order of the War Department (Bulletin 64, 1918) prescribes scales of maps to be used by the Army as 1:10,000, 1:20,000, 1:62,500 and 1:200,000. In this order no definite contour interval is fixed for maps of various scales, but it is to be some multiple of 5 ft. or 10 ft., "having in view the maximum detailed delineation of the ground consistent with cartographic clearness." This provides for some freedom of the topographic expression, although it gets away from the idea of "the unit system of scales and contour intervals," which, although facilitating the reading of maps, leaves but little room for interpreting topography in various kinds of country.

Decimal and Metric Scales

Confusion has sometimes arisen between the adoption of the decimal scale for maps and the adoption of the metric system for measurements, but these two questions are entirely independent of each other, says Colonel Marks. Maps drawn on scales of inches to the mile can be used only with very special scales, which cannot be ordinarily obtained, whereas a map drawn to the decimal scale lends itself to uses with any measuring scale, simply by multiplication. On a map drawn to the decimal scale, it is immaterial which system of units is used, since measurement in any system of units may be performed by means of scales in the same system, and commercial scales dividing feet into hundredths, and yards or meters into thousandths, may be obtained readily.

When distances in miles are required, the fact that the 1:10,000 and 1:20,000 scales are within about 5% of 6 in. and 3 in. to the mile, respectively, enables close estimates to be made, while with a map measurer or auxiliary scale distances may be determined quickly by simple arithmetic. To sum up, the use of a decimal scale for maps lends itself generally to measurement in any system of units, but this is not true of any scale which is based upon the relation between inches and miles.

Colonel Marks agrees that the adoption of the 1:62,500 scale is unfortunate, but he suggests that as the majority of topographic maps of this country exist to this scale, possibly the benefit resulting from a change would not be consistent with the large expenditure of funds required to reproduce the existing maps on a scale of 1:40,000 or 1:50,000.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Diagram for Machine-Banded Wood-Stave Pipe

Sir—I have read with interest the article on p. 472 of your issue of Sept. 4, 1919, by Willis T. Batcheller, giving a diagram for computing band spacing for wood-stave pipe.

The accompanying diagram for machine-banded wood-stave pipe is one being used in the office of the Chief of Construction, United States Reclamation Service, Denver, Colo., and has proved very satisfactory. It is more complete than Mr. Batcheller's diagram, in that it gives the spacing for any unit working stress in the steel within the range of 10,000 to 15,000 lb. per square inch. It also gives the spacing required in order that the bearing stress of the band on the wood will not exceed safe limits. A similar diagram can readily be prepared for continuous wood-stave pipe, and such a diagram has been published on p. 253 of my book, "Working Data for Irrigation Engineers."

To illustrate the use of the diagram here shown, assume that it is required to know the spacing for No. 1-gage wire for 30-in. pipe, to operate under a static head of 55 ft.; the tensile strength in the wire not to exceed 12,000 lb. per square inch and the bearing stress on the wood not to exceed 800 lb. per square inch.

Starting at 55-ft. head in the left-hand diagram for stress in bands, go horizontally as shown by the heavy dotted line to the intersection with the oblique line for 30-in. diameter pipe, thence vertically downward as shown by the heavy dotted line to the intersection with the horizontal line for the 00-gage wire, thence obliquely downward to the left of the intersection with the No. 1-gage wire, where the spacing required is shown to be 2 in. If the spacing for wire of any other size is required, it is similarly found by reading the spacing at the intersection of the downward to the left oblique line with the required size of wire.

If it is required to find the spacing for any other stress in the steel than 12,000 lb. per square inch, it is done by continuing vertically downward as shown by the dotted line to the intersection with the horizontal 12,000 lb. per square inch line marked "reference line" and thence obliquely upward to the left—or downward to the right, as the case may be—and as shown to the intersection with the horizontal line representing the required stress in the steel, and reading by the vertical lines at that point the required spacing.

The determination of the required spacing as governed by the bearing stress on the wood is made in a similar manner, as shown on the right-hand diagram for bearing on wood. For the assumed example, this spacing is 5½ in. for a safe bearing pressure on the wood of 800 lb. per square inch. It is seen in this case that the spacing of the bands is governed by the stress in the bands.

The small diagram in the lower right-hand corner shows the dividing line between the combinations of diameter of pipe and size of wire for which the stress in the steel at 12,000 lb. per square inch governs, and those in which the bearing stress on the wood at 800 lb. per square inch governs.

E. A. MORITZ,
Engineer, United States Reclamation Service.
Denver, Colo.

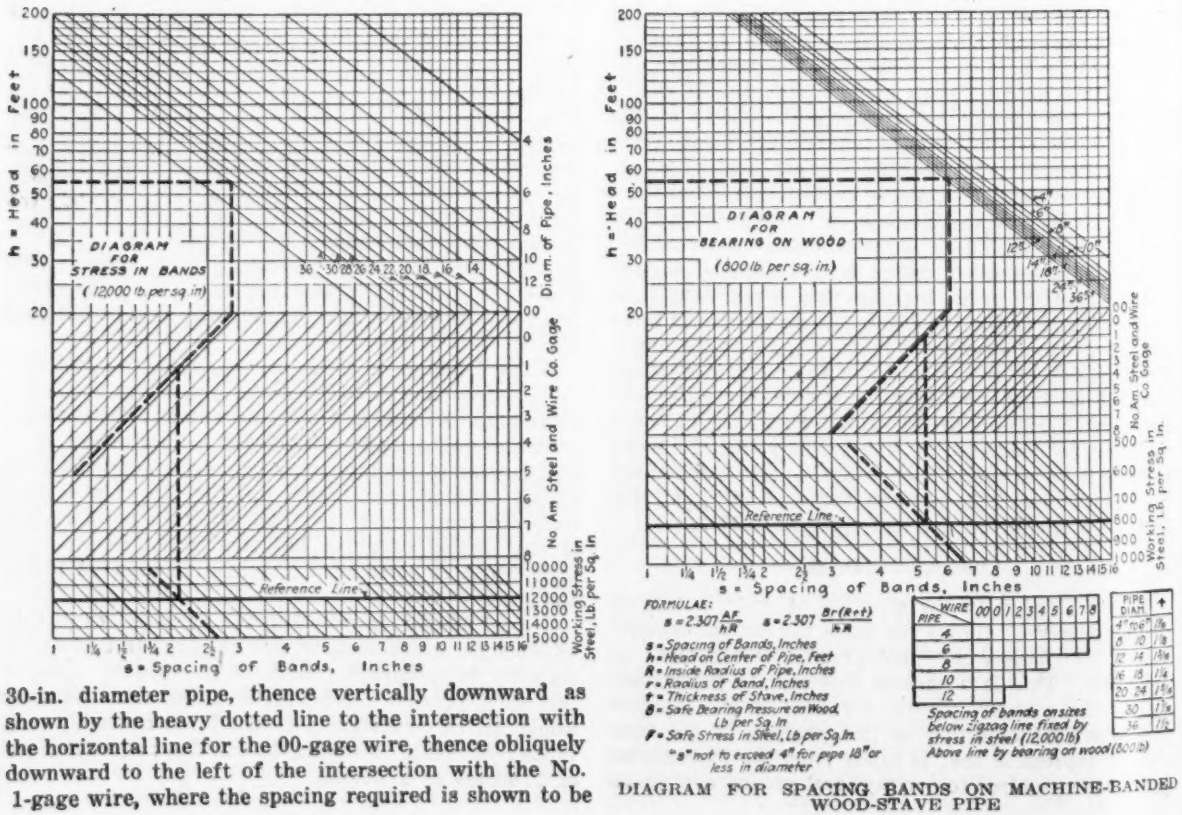

h = Head in Feet
DIAGRAM FOR STRESS IN BANDS
(12000 lb per sq in)
Reference Line
s = Spacing of Bands, Inches
Diam. of Pipe, Inches
No Am Steel and Wire Co Gage
Working Stress in Steel, Lb per Sq In
DIAGRAM FOR BEARING ON WOOD
(800 lb per sq. in)
FORMULAE:
s = 2.307 Af/hR
s = 2.307 Br(R+t)/hR
s = Spacing of Bands, Inches
h = Head on Center of Pipe, Feet
R = Inside Radius of Pipe, Inches
r = Radius of Band, Inches
t = Thickness of Stave, Inches
B = Safe Bearing Pressure on Wood, Lb per Sq In
f = Safe Stress in Steel, Lb per Sq In.
"s" not to exceed 4" for pipe 18" or less in diameter
WIRE
PIPE
PIPE DIAM
Spacing of bands on sizes below Zigzag line fixed by stress in steel (12,000 lb)
Above line by bearing on wood (800 lb)

DIAGRAM FOR SPACING BANDS ON MACHINE-BANDED WOOD-STAVE PIPE

An Answer to the Water-Hammer Question

Sir—In your issue of Sept. 11, 1919, p. 530, B. Gibson, Decatur, Tex., describes an experience with

water-hammer in mains and services of the local water-works. He states that he has a 16 x 12-in. double-action piston pump driven by a motor at 50 r.p.m., lifting water 12 ft. from the reservoir through mains to a 90- or 100-ft. tank, and that he has a 7 x 15-in. air chamber 3 ft. from the pump on the discharge line. There are several possible causes for this water-hammer.

One may be the design and size of the intake, as well as the gradient of the main from the pump to the tower, which would involve the question of the hydraulic mean gradient, which might cause air pockets, etc. The lift, which he states is 12 ft., may also be involved, as when the pump is revolving at 50 r.p.m this 12-ft. lift may be increased beyond the atmospheric pressure on account of an inadequate supply of suction, and this would account at once for the water-hammer.

If Mr. Gibson would cut down his 50 r.p.m. to possibly 28 or 30 I think this will stop his water-hammer. In a plant in Nebraska I found that an inadequate supply of water from artesion wells, while running the pump at full capacity, produced water-hammer. By reducing the revolutions and pumping longer hours, this hammering was obviated.

Neligh, Neb. NELSON B. SWEITZER.

Anchorages, Cables and Lateral Stays in Suspension Bridges

Sir—While the Cumberland suspension bridge described in *Engineering News-Record* of July 3, 1919, is hardly of a magnitude to merit further discussion, Mr. Grove's reply to my comment in your issue of Sept. 11, 1919, p. 527, makes further reference to the subject necessary.

Regarding the submerged anchor: If the 25-ft. piles driven under the concrete blocks were extended up into the concrete and notched, there would seem to be no possibility of the anchor being pulled out until the piles decay. But the load conditions taken into account here are very different from those assumed for the cables.

We have here a footbridge of unusual length carrying an unusually heavy traffic, to which most careful consideration was given in design. The cables, whose strength is a fairly certain quantity, are designed for a live load of 400 lb. per linear foot, with a factor of safety of 5. The submerged anchor, which even the best informed must admit to be a less certain matter, is designed with a factor of 2; and even to arrive at this very slim factor of safety it is necessary first to increase the weight of concrete from 135 to 150 lb. per cubic foot, then assume that there will be no hydrostatic pressure, and finally cut the assumed live load in two. If 184 lb. per linear foot is the proper live load instead of 400 lb., as the anchorage calculations would indicate, then much money was spent on the cables that rightly should have gone into the anchors, and in any event the expensive, unsightly and extremely inconvenient arrangement at the saddles made necessary by the change of size of cables could have been avoided.

The design of the lateral systems for structures of the kind in question is apt to be not so much a matter of rigidity and cross-section of stress-carrying members as safeguarding against excessive swinging. It seems almost impossible to provide against this swinging unless wind cables are used. The writer knows of cases where stay cables had to be placed after the bridge was completed on account of swinging, although the lateral bracing had been designed for a wind load of 200 lb. per linear foot. Let us assume for the Cumberland bridge that the wind load on the bottom chord is only 100 lb. per linear foot, although most specifications call for three times this amount. The span being 540 ft. long and 9 ft. wide, there would be a maximum stress in the bottom chords of the stiffening truss of about 30,000 lb. per square inch. We then have this extreme case: A lattice girder 540 ft. long by 9 ft. deep, with its chords stressed to 30,000 lb. per square inch; what is its deflection? It would indeed be interesting to know whether this bridge does not swing considerably. D. ORDING,

Assistant Engineer, Midland Bridge Company.

Kansas City, Mo.

Method of Laying Out Split-Switch Turnout

Sir—During the winter of 1918-19 the writer laid out several split switch turnouts. I disagreed with the office engineer on the correct theory. His method is as follows:

Use a table of stub switch turnouts for the lead and make the curve back of heel of frog the same as given in table for curve in the lead. In running out the turnout, first deciding upon the location of point of switch—setting up the transit on this point—turning tangent and continuing the turnout curve through the switch and frog. Locating the point of frog by measuring from the point of switch back, the distance given in table for a stub switch lead.

This method is objectionable by reason of the fact that both the switch points and frog are straight, and no allowance is made for this, causing an angle both at the heel of the switch point, and the toe and heel of the frog. As most of the turnouts are No. 4 and No. 5, this angle is quite acute, and the following curve would be 38° 45′ 57″ and 24° 31′ 36″, respectively. Over 75% of the derailments occurred in turnouts.

My theory is that a table of split switch turnouts should always be used, and that the degree of curve back of the heel of the frog is not necessarily absolutely the same as the curvature in the lead.

Standard frogs and switch points for A.R.E.A. specifications were used.

I was unable to convince some of my associates of the correctness of my theory, and I should appreciate discussion through *Engineering News-Record.*

Cleveland, Ohio. L. C. SCOTT.

Pollution by Industrial Wastes Enjoined

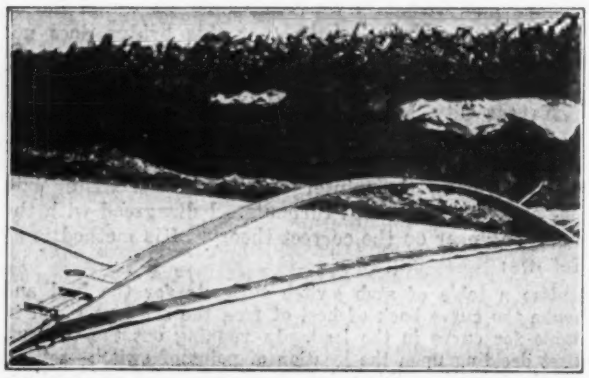
Discharge of industrial wastes into the branches of the Rahway River from the plant of the Chemical Co. of America, located in Springfield Township, N. J., five miles above the point on the Rahway River from which the water-supply of Rahway, N. J., is drawn, has been enjoined by the Chancery Court of New Jersey, effective Oct. 1. The decision and order in the case are dated May 27, 1919, and are printed in *Public Health News* (State Department of Health, Trenton, N. J.) for August, 1919. The company provided some 4½ acres of lagoon for disposal by evaporation, but the dikes forming it were not water-tight. Ditches were then built outside the dikes, and the seepage pumped back into the lagoon, but this was insufficient.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Steel Ribs on Wide Concrete-Fininshing Belt Prevent Warping

WIDE belts for finishing concrete-road surfaces are considered by many engineers as preferable to narrow belts, but there has been great difficulty in keeping them from warping and digging into the finished surface. This difficulty has been overcome by Thomas, Bennett & Hunter, on one of the projects of the Maryland State Road Commission, by riveting steel ribs on the upper face of the belt, as shown in the illustration.



WIDE FINISHING BELT KEPT FROM WARPING BY STEEL STIFFENERS

The ribs are placed about 1 ft. on centers, and, for a distance of 1 in. back from the front, are bent upward about ¼ in. This keeps the front edge of the belt from digging the concrete surface. John N. Mackall, from whom the above information was received, states that this device has given the most satisfactory finish for concrete roads that he has seen.

Resource of Contractor Saves Labor

By W. F. Reichardt

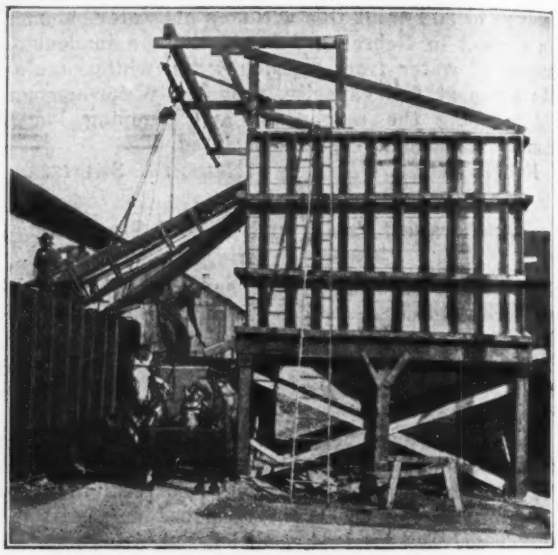
Municipal Consulting Engineer, Watertown, Wis.

IT HAS been the experience of nearly every engineer that the unstability of labor has caused more trouble this season than any other condition, and on some work a contractor was unable to carry on his work unless he was able to find some method of saving labor. This was the situation at Edgerton, Wis., where Lee Alder, contractor, had obtained a contract for the construction of 30,000 sq.yd. of one-course reinforced-concrete pavement. Realizing at the start that labor would be scarce, this young contractor worked out a novel and satisfactory method of saving labor.

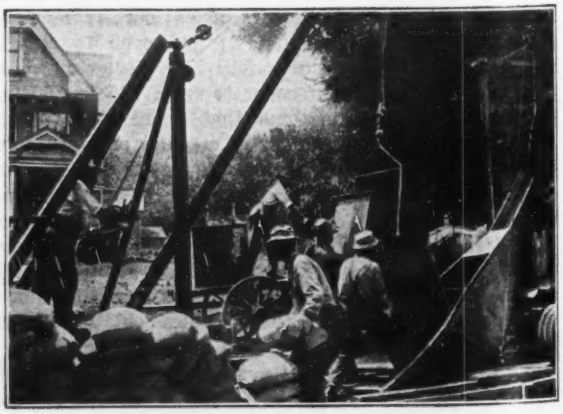
Mr. Alder constructed a bin which would hold five carloads of sand and gravel. He then purchased an electric conveyor with which he unloaded all aggregates into this bin. By the use of the conveyor, he required only two men to unload the car, whereas ordinarily he would require four.

The question that next confronted this contractor was how he would get the materials into the hopper of the mixer. He had constructed sheet-steel boxes holding 15 cu.ft. The boxes contained 9 cu.ft. of pebbles and 6 cu.ft. of sand. The boxes were marked so that any laborer could get the exact proportions when loading from the bin. This method was of much value to the engineer, for he knew the proper proportions would be maintained because the boxes would not hold more than 15 cu.ft. of aggregates.

These boxes were hauled to the mixer on flat wagons, each wagon carrying four boxes. The wagon was placed alongside the mixer, and by the aid of a derrick the boxes were unloaded or emptied into the skip without loss of materials or much time. With each box emptied into the skip, three bags of cement were added. An additional feature, though it did not concern labor materially, was the use of a derrick independent of the mixer, thus avoiding a great deal of the wear and tear



ELECTRIC CONVEYOR FILLS BIN FROM CAR



STEEL BUCKETS CONTAIN EXACT MIXTURE OF AGGREGATE

a mixer usually suffers through the attachment to it of a derrick for handling materials from a wagon or truck to a mixer hopper.

This method assured the engineer of the very best mixture, as there was no chance to get dirt into the sand and gravel, the material never touching the ground from the time it left the pit until in the finished paving mixture. This in itself was worth the cost of this method, even though it added to the original cost. However, the contractor also saved by this method, and an average day's run consisted of 203 lin.ft. of pavement 23 ft. wide with a 6 x 6-in integral curb, using a total of eight men, including the mixer operator and every other man laying concrete.

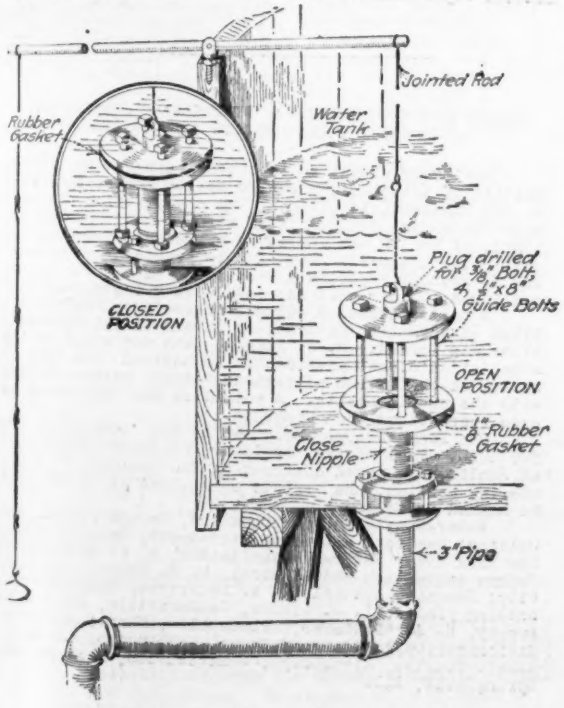
This method is without doubt one of the best I have seen in use and while it has saved the contractor money and made the completion of his contract possible, it has given me the best mixture I have ever secured and is as nearly accurate as it can possibly be made.

Home-Made Quick-Opening Valve Works Well for Small Water Tanks

By D. J. McFadden,
New Jersey State Highway Department, West Portal, N. J.

A VALVE which acts quickly in small water tanks for supplying donkey engines from the tanks can be made by any blacksmith on contract work. The valve has simple working parts, does not leak and is inexpensive.

To construct the valve, which is shown in the accompanying illustration, all that is required is a flanged pipe union for whatever size pipe is desired, a pipe plug, a close nipple and four bolts. The bolts used should be one size smaller than those for which the flange is drilled, so that the valve will work freely, the bolts being only used as a guide for the top flange.



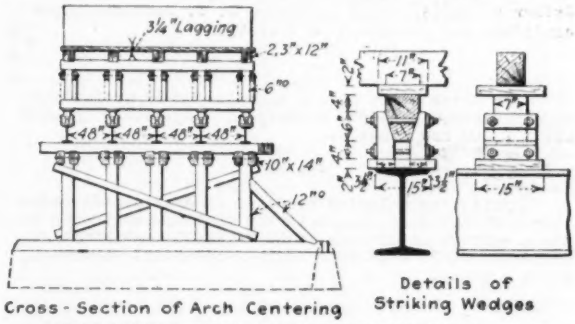
DETAILS OF SMALL, QUICK-ACTING VALVE

To keep the valve from leaking a ⅛-in. sheet-rubber gasket should be used, as shown in the illustration. The operation of the valve, which is shown open, is apparent. The closed position of the stopper is shown by the dotted line.

This device has been used on many contracts by the writer, with perfect satisfaction. It is not liable to freeze up, as it is completely immersed in water.

Spreading Wedge for Striking Arch Centers

IN BUILDING a concrete arch bridge over the Linth River, at Schwanden, for the railway line between Glarus and Linthal, Switzerland, to take the place of an iron lattice-truss bridge in service since 1879, the contractor (J. J. Rüegg, Zürich) used a new lowering device. It is a spreading wedge, held together by bolts, as sketched herewith after the *Schweizerische Bauzeitung* of Aug. 16, 1919. In describing the bridge



SPREADING WEDGE IN CENTERING FOR SWISS RAILWAY ARCH

and its construction, A. Bühler, bridge engineer of the Swiss Federal Rys., says that the wedge device proved very satisfactory.

The bridge has two arch spans, respectively 72 and 97 ft. between abutments. Both spans are of three-hinged construction, but of an unusual type in that the end hinges, instead of being at the skewbacks, are located some distance out, so that in the case of the larger arch the span between hinges is 82½ ft. The arch ring is 40 in. thick at the crown and 53 in. thick at the ends. As the posts of the centering were spaced 4 ft. apart transversely and about 8 ft. apart longitudinally, each wedge carried about 8½ tons when the ring was fully concreted. The crown settlement at time of striking centers was ¾ inch.

Dam and Reservoir Without a Spillway

Rensselaer Lake, a reservoir formed by a low earth dam built for the water-supply of Albany, N. Y., in 1852, with William J. McAlpine as engineer, has no spillway. It has a storage capacity of 130,000,000 gal., an area of about 30 acres and a drainage area of two to three square miles. The dam is 34 ft. high over all, is carried 8 ft. above the water level, is 10 ft. wide on top, has an inner slope of 1½ to 1 and an outer slope of 2 to 1. It has a puddled clay heart-wall 8 ft. thick at the top which increases 4 ft. in thickness for each 10 ft. in depth, and its upper slope is lined with puddle. The dam is protected from overwashing by opening gates in an overflow pipe. It is thought that the drainage area affords a large amount of ground storage. Wallace Greenalch is commissioner of public works of Albany.

NEWS OF THE WEEK

New York, October 9, 1919

DIGEST OF OCTOBER NEWS

(Editor's Note: As a matter of record there is given below a digest of news from the several Emergency Bulletins which this journal published while its regular issues were delayed by the printers' strike.)

Development committee, Am. Soc. C. E., completed final report and was discharged.

Nominating committee, Am. Soc. C. E., selected Arthur P. Davis, chief engineer, U. S. Reclamation, as candidate for president of society.

In drive begun Oct. 6 and directed by professional organizer, Western Society of Engineers gained about 2,000 new members.

Following salaries proposed in American Association of Engineers schedule for highway engineers in state employ: Draftsmen, $1800 - $2400; assistant engineers, $2400 - $4000; first assistant engineers, $3600 - $5000.

Mainly through efforts of members of local engineering societies an engineer, Charles H. Lee, of Los Angeles, has been appointed by the governor of California as State Water Commissioner.

Contract let for $2,384,458 memorial bridge over Susquehanna River at Harrisburg, Penn.

Committee from Engineering Council went to Washington to endorse plan for national budget.

Architects, instead of engineers, have been given charge of designing and supervising construction of two big Pittsburgh bridges. One or both structures may call for 500-ft. steel arch spans.

Permanent coordinating Board of Surveys and Maps recommended by conference at Washington, D. C. of 14 Government map-making agencies and 12 engineering or scientific societies. Engineering Council suggested the conference in letter to President.

About 230 cities and towns have settled claims for septic tank royalties under recent agreement between Cameron Co. and National Septic Process Protective League.

Columbia Basin Survey Commission, with $100,000 appropriation for its work, is completing surveys for immense irrigation project in State of Washington.

Future military policy of U. S. discussed at New York meeting, Am. Soc. C. E., Major-Gen. W. M. Black Chief of Engineers, U. S. A., taking leading part.

Street car terminal subways for Detroit recommended. City council approved project.

Baltimore authorities urged by local chapter, American Association of Engineers, to increase pay of all city's engineers. Similar request made on Cincinnati Rapid Transit Commission.

One of world's largest hydroelectric projects begun on Winnipeg River, Canada. Involves concrete dam 2000 ft. long and 70 ft. high and eight 21,000 hp. turbines.

Following Attorney General's opinion, War Department resumed delivery of surplus army motor trucks to State Highway Departments, but further legal complications leave ultimate result of transfer in doubt.

By overwhelming vote Maine decided to increase bonded indebtedness from $2,000,000 to $10,000,000 for good roads.

Engineering Council elected to membership in Chamber of Commerce of United States.

National Safety Council has organized an Engineering Section.

American Association of Engineers has established federal department with offices in Washington.

HEALTH TOPICS DISCUSSED AT NEW ORLEANS CONVENTION OF AMERICAN PUBLIC HEALTH ASSOCIATION

Engineers played an important part in 47th annual meeting of the American Public Health Association held at New Orleans Oct. 27-30. An organization to meet with the annual conference of state and provincial boards of health was formed by engineers connected with state health departments. In his presidential address Lee K. Frankel reported a membership of 4500, representing a 100 per cent increase during the year.

A national health council embracing representatives of seventeen national or international organizations was formed. W. S. Rankin, who was named as the association's next president, emphasized the need of better co-ordination of various Federal bureaus dealing with the public health. A committee was appointed to urge these views upon Congress.

San Francisco was selected as the convention city for 1920. Paul Hansen, engineer, Illinois Department of Health, was named chairman of the Sanitary Engineering Section, the various committees of which will be headed as follows:

Water-Supply and purification, George G. Earl, New Orleans; Sewerage and sewage treatment, Kenneth Allen, New York City; Waterways sanitation, H. P. Eddy, Boston; Refuse collection and disposal, M. N. Baker, New York City; Mosquito control, J. A. Le Prince, Memphis, Tenn.; Bathing places, I. W. Simons, Jacksonville, Fla.; Milk supply, H. A. Whittaker, Minneapolis, Minn.; Air conditioning, Major George A. Soper, Washington; Housing, Morris Knowles, Pittsburgh; Constitution, Paul Hansen, Springfield, Ill.

WAVES BREAK HARMLESSLY ON GALVESTON'S SEA-WALL

During the hurricane which swept over the coast cities of Texas on Sept. 14 the sea-wall at Galveston fulfilled the object for which it was built. The accompanying photograph, received from City Engineer C. A. Holt, Jr., gives an indication of how the huge waves were stopped by the concrete barrier. An idea of the height of the column of water may be gained by comparing it with the arc lamp pole on the right. The top of this pole, Mr. Holt states, is about 30 ft. above the sea-wall.

BRIBERY CHARGES AGAINST ROAD-MACHINERY AND PAVING COMPANIES

The Federal Trade Commission on Nov. 7 issued formal complaints charging unfair competition against thirteen interstate road-machinery and street-paving companies. Alleged bribery of public officials is one of the charges of unfair competition which will be heard when the case goes to trial.

Ten of the concerns are cited in the complaints for alleged giving of gratuities such as meals, cigars, entertainment and the like, and for alleged secret paying of sums of money to public officials and employees of customers; and also for alleged payment of the expenses of public officials for visits to the concerns' plants for the inspection of road machinery. These gifts and payments, the complaints allege, were for the purpose of influencing public officials and the employees of their customers to recommend, purchase or contract to purchase road machinery, street-cleaning machinery or like products.

The ten companies are: The Good Roads Machinery Co., Kennett Square, Penn.; Acme Road Machinery Co., Village of Frankfort, N. Y.; Buffalo Steam Roller Co., Buffalo; Russell Grader Manufacturing Co., Minneapolis; The Austin-Western Road Machinery Co., Chicago; Charles Hvass & Co., Inc., New York City; J. D. Adams & Co., Indianapolis; Stockland Road Machinery Co., Minneapolis; The Barr Sales Co., Chicago; and Galion Iron Works and Manufacturing Co., Galion, Ohio.

Two other companies were cited for giving of gratuities and paying the traveling expenses of public officials. They are: The Chamberlain Road Machine Co., Hutchinson, Minn., and The Barber Asphalt Paving Co., Philadelphia. The Dyar Supply Co., Cambridge, Mass., was cited for giving of gratuities and the secret payment of sums of money to public officials and employees of customers.

The thirteen concerns were directed to file answer with the Commission at Washington, Dec. 22.

ROADS' RETURN BY JAN. 1 NOW SEEMS CERTAIN

The Interstate Commerce Committees of Congress have agreed on a tentative program, in the form of an interim bill, to be enacted to the end of protecting all interests with the return of the railroads to their owners on Jan. 1 according to the announced intention of President Wilson, which has been reiterated by Director-General Hines.

NO PROVISION YET FOR FEDERAL HIGHWAY COMMISSION

No plan has been formulated as yet for taking up the Townsend Bill which provides for a Federal highway commission and the formation of a national highway system. The bill is before the Senate Committee on Post-offices and Post Roads. No attempt will be made to consider the bill at this session of Congress and no definite arrangements have been made for its consideration at the regular session.

GENERAL BLACK RETIRES AS CHIEF OF ENGINEERS

Maj. Gen. William M. Black, Chief of Engineers, U.S.A., retired from active service in the army Nov. 1 after more than 46 years of service. He has been appointed chief engineer of the Shipping Board.

He was graduated from the United States Military Academy at West Point in 1877 and has served in the army continuously since that time. His appointment as Chief of Engineers took place in March, 1916. Col. Frederick V. Abbot, ranking officer, Engineer Corps, is now acting as Chief of Engineers and it is anticipated that he will be nominated by the Secretary of War as successor to General Black.

NEW BRIDGE PLAN FOR PITTSBURGH

A proposal that the new Allegheny River bridges at Pittsburgh be equipped with liftable spans to accommodate them to the clearance requirements at all river stages, instead of building fixed spans at the height dictated by the maximum stage, has been made to local authorities by A. A. Henderson, of Wilkinsburg, Penn. At present fixed bridges are being designed to meet the War Department's requirements as to span lengths and navigation clearance. They involve steep approach grades. Under the liftable-span system the steep grades would exist only at high flood stages.

STRENUOUS OPPOSITION TO GRAND TRUNK PURCHASE

Strong opposition is developing in the Canadian Parliament to the proposed bill, embodying the terms of agreement entered into recently by the Canadian Government authorities and the officials of the Grand Trunk System, for the taking over of the Grand Trunk properties by the Government, by purchase of securities through the medium of long-term bonds. It is freely charged that an attempt is being made to saddle the Canadian Government with the losses of stockholders through the Grand Trunk Pacific venture and other projects.

The United States Government may oppose such ownership of Grand Trunk lines in this country.

GENERAL CONTRACTORS PLAN HIGHWAY CONFERENCE

A conference of road contractors will be held in Chicago late in November under the auspices of the Associated General Contractors of America to aid the association in formulating a representative opinion on road construction contracts and contractual policies to be presented on invitation of the American Association of State Highway Officials at their coming annual convention.

Among the subjects upon which an expression of thought is desired are the following: (1) The necessity for an increase in the size of highway contracts; (2) consideration as to whether grading and paving should be let in the same or in separate contracts; (3)

the effect of the shortage of open top cars on highway work in 1919; (4) the need for utilization of local supplies of aggregate that can be delivered direct to the job by motor truck or industrial railway, as a means of reducing cost and of relieving the probable car shortage of 1920; (5) the use of dry mixtures in concrete pavement construction and its effect on the contractor's work; (6) the needless refinement of some specifications for hard-surface pavements; (7) the value of utilization of the cost-plus-fixed-fee, with adjustments, form of contract on highway work; (8) the elimination of unreliable and incompetent contractors from consideration in awarding contracts; (9) letting contracts in the fall so that all arrangements may be made for an early start of work in the spring, and a reserve supply of aggregates accumulated during the winter, and (10) provision for safeguarding the contractor against unnecessary risks, as for example the assumption by the state of increased costs due to an advance in freight rates.

Road contractors are urged to attend this conference and to write the secretary, G. W. Buchholz, 111 W. Washington St., Chicago, of their intention so that proper arrangements can be made. In case attendance is impossible a discussion by letter will be welcomed.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF PORT AUTHORITIES, 75 Montgomery St., Jersey City, N.J.; Nov. 17-19, Galveston, Tex.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 W. 39th St., New York City; Dec. 2-5, New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Secretary, J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.; Dec. 3-6, Savannah,

NATIONAL RIVERS AND HARBORS CONGRESS, 824 Colorado Building, Washington, D. C.; Dec. 9-11, Washington, D. C.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Secretary, Joseph Hyde Pratt, Chapel Hill, N. C.; Dec. 8-11, Louisville, Ky

AMERICAN MATHEMATICAL SOCIETY, Secretary, F. N. Cole, 501 W. 116th St., New York City; Dec. 30-31, New York City.

BRIDGE BUILDERS' & STRUCTURAL SOCIETY, 50 Church St., New York City; Jan. 16, New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS, 29 W. 39th St., New York City; Jan. 21-22, New York City.

The Iowa Section of the American Water Works Association elected the following officers at the meeting Oct. 22-23: Chairman, G. B. Shoemaker; vice-chairman, F. D. H. Lawlor; directors, R. B. Wallace and F. B. Ross. The parent association will be petitioned for the extension of territory to include Nebraska, South Dakota and adjoining states not having sections. The next meeting will be in Iowa City. Jack J. Hinman, Jr., is secretary.

The Cleveland Engineering Society, on Nov. 4, was addressed by C. H. Benjamin, dean, Schools of Engineering, Purdue University, who read a paper on "New Requirements in Technical Education."

The Indianapolis Chapter of the American Association of Engineers will hold a regular meeting on Nov. 14 for the election of officers and for the consideration of various resolutions regarding the present labor and industrial problem.

A Phoenix Chapter of the American Association of Engineers may be the result of a recent organization of professional engineers in Phoenix which has applied to the national body for a charter. As last reported the temporary officers are: President, B. L. Hitchcock; organization committee, F. M. Nichols, E. R. Hayden and James E. Sellers; secretary, D. A. McClung

The Oklahoma Society of Engineers recently held its annual convention at Oklahoma City. The following officers were elected: President, Dan W. Patton; vice-presidents, Frank B. King, R. E. Brownell, and George Stein; secretary-treasurer, H. V. Hinkley.

The Southwestern Society of Engineers has voted to affiliate with the American Association of Engineers, according to announcement by the latter.

The Engineers' Club of Philadelphia will hold a regular meeting Nov. 18 at which Hon. Edward M. Bassett, counsel for Zoning Committee, New York City, will speak on "Conference on Comprehensive City Planning." A junior meeting will be held Nov. 11, at which Thomas H. Winston will speak on "The Signal Corps as the Nerve System of the A. E. F." At the weekly luncheon, Nov. 11, Dr. R. Tait McKenzie will present a paper on "Physical Training for University Men" and on the 18th George S. Webster, on "The Development of Facilities for Trade."

The Northwest Society of Highway Engineers has voted to affiliate with the American Association of Engineers, according to announcement of that body.

PERSONAL NOTES

Frank H. Clark, formerly general superintendent of motive power, Baltimore & Ohio R.R., now consulting engineer, New York City, left Oct. 4 for Pekin, China, to act as technical adviser to the Ministry of Communications of the Chinese Republic.

Ezra B. Whitman, consulting engineer, Baltimore, Md., has just returned from a three months' professional trip to Poland

G. H. Clevenger, vice-chairman and acting officer of the Engineering Division of the National Research Council, with office in New York, has given up his active supervision of the work of the Council and will leave shortly to fill a professional engagement in Mexico. Upon his return some months hence he will open an office in New York City as consulting engineer, specializing in metallurgical lines.

Harry Barker and Robert C. Wheeler have become associated in partnership and will engage in the private practice of engineering at 170 Broadway, New York City. In military service Mr. Barker was a captain of engineers and Mr. Wheeler held the rank of major in the Construction Division.

Robert E. Horton, consulting engineer, 57 North Pine Ave., Albany, N. Y., announces change of address to R. F. D. No. 1, Voorheesville, N. Y.

Capt. Robert B. Murdock, U. S. A., recently discharged from the service, has been appointed executive engineer, Asphalt Association, New York.

OBITUARY

Col. William R. Livermore, U. S. A., retired, who, together with English engineers, laid the cable from the United States to Havana in 1868 and who, as a young officer in the Corps of Engineers, was connected with fortification work at Key West, Tortugas, and Atlantic Coast ports, died Sept. 27 at the army hospital New York City, aged 77 years.